Study of Impacts Caused by Exempting the Maine Turnpike and New Hampshire Turnpike from Federal Truck Weight Limits

Draft Final Report

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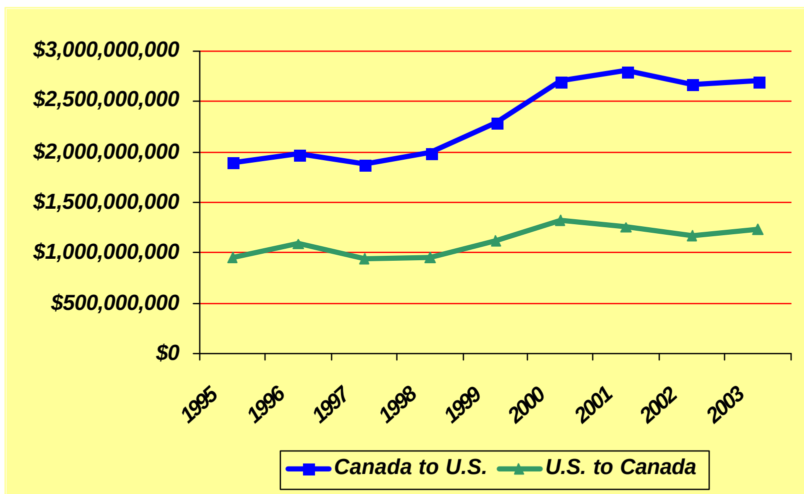
Introduction

Regulations governing truck size and weight have impacts on highway safety, infrastructure preservation and economic efficiency. Truck size and weight laws also carry implications for regional and national economies as transportation has become a substitute for inventories in modern supply chain management. In the U.S., federal laws govern truck size and weight (TS&W) on the Interstate Highway System. Federal TS&W laws are of particular importance to U.S. border-states heavily impacted by the North American Free Trade Agreement. The chart in **Exhibit 1** shows that in 2003 exports from Maine and New Hampshire exceeded $1 billion, with nearly all this trade traveling by truck. Both Canada and Mexico allow significantly higher truck weight limits in their respective counties. As a result, U.S. companies competing against cross-border rivals in natural resource based industries, where profit margins are typically low, find it difficult to compete against foreign competition that is able to use more efficient means of transportation.

Exhibit 1: Maine/New Hampshire Cross Border Trade



The transportation needs of natural resource based industries like agriculture, timber and ore extraction are traditionally characterized by heavy commodities moving relatively short distances. In 1998, 92 percent of all freight (by weight) originating in Maine was transported by truck and 75 percent of all originating truck flows moved 250 miles or less. In New Hampshire, 96 percent of all freight (by weight) originating in the state moved by truck. 76 percent of all truck flows originating in New Hampshire moved 250 miles or less.[1] Railroads and waterborne modes are also well suited for moving heavy commodities, but the economics of rail and water normally dictate hauls much longer than 250 miles. Given the composition of the Maine/New Hampshire regional economy, it is likely that both states will rely heavy on truck transport in the future.

Maine's state truck weight limits have been enforced on the Turnpike since it was constructed in the late 1940's. The Maine Turnpike was designated part of the Interstate Highway System in 1956, but as no federal funding was used in its construction, the practice of enforcing state weight laws continued. The 15-mile New Hampshire Turnpike opened to traffic in 1950 and was designed part of I-95 in 1960. In 1994, the Federal Highway Administration (FHWA) threatened to withhold state funds for not enforcing federal Interstate weight limits on the Maine and New Hampshire Turnpikes. The State of Maine then sought and obtained an exemption from Congress formalizing its long-standing practice of enforcing state weight limits on the Maine Turnpike. In keeping with the policy and practice of Maine, New Hampshire also enforced its higher state weight limits the New Hampshire Turnpike.

Background

In 1913 Maine was one of the first states to limit truck weight in order to protect highway pavements and bridges. The federal government did not regulate TS&W limits until 1956, establishing a maximum gross weight limit on Interstate Highways of 73,280 pounds (lbs.). States with higher weight limits prior to July 1, 1956, were allowed to retain those limits as "grandfathered" rights. In 1975 Congress increased the allowable GVW (GVW) on the Interstate System to 80,000 lbs. Since 1982 there have been no changes in federal weight limits. Title 23 USC, 127 provides the following limits on Interstate Highways:

- Single axle weight limit: 20,000 lbs.
- Tandem axle weight limit: 34,000 lbs.
- Gross vehicle weight limit: 80,000 lbs.
- Comply with federal bridge formula

In 1998, Congress provided partial GVW exemptions to four states: Colorado, Louisiana, Maine and New Hampshire. The Transportation Equity Act for the 21st Century (TEA-21) provided exemptions from the federal GVW limits on the Maine and New Hampshire Turnpikes (**Exhibit 2)**.

Exhibit 2: TEA-21 Truck Weight Excerpts

TEA-21 - Transportation Equity Act for the 21st Century Subtitle B--SEC.1212; (d) Vehicle Weight Limitations.

(1) Section 127(a) of title 23, United States Code, is amended:

(B) With respect to Interstate Route 95 in the State of New Hampshire, State laws (including regulations) concerning vehicle weight limitations that were in effect on January 1, 1987, and are applicable to State highways other than the Interstate System, shall be applicable in lieu of the requirements of this subsection.

With respect to that portion of the Maine Turnpike designated Interstate Route 95 and 495, and that portion of Interstate Route 95 from the southern terminus of the Maine Turnpike to the New Hampshire State line, laws (including regulations) of the State of Maine concerning vehicle weight limitations that were in effect on October 1, 1995, and are applicable to State highways other than the Interstate System, shall be applicable in lieu of the requirements of this subsection."

(C) Maine.-- (i) …In consultation with the Secretary, the State of Maine shall conduct a study analyzing the economic, safety, and infrastructure impacts of the exemption provided by the amendment made by paragraph (1)(B), including the impact of not having such an exemption. In preparing the study, the State shall provide adequate opportunity for public comment.

(D) New Hampshire.-- (i) In general.--In consultation with the Secretary, the State of New Hampshire shall conduct a study analyzing the economic, safety, and infrastructure impacts of the exemption provided by the amendment made by paragraph (1)(B), including the impact of not having such an exemption. In preparing the study, the State shall provide adequate opportunity for public comment.

Non-exempt Interstates in Maine and New Hampshire remain subject to the federal GVW limit of 80,000 lbs. Exempt portions of I-95 and state highways allow a GVW of up to 100,000 lbs on six-axle TST combinations and certain commodity groups are also allowed a 10% GVW tolerance on 5-axle configurations. As a result, heavy trucks that would otherwise be through traffic on I-95 divert to state highways upon reaching non-exempt portions of I-95.

In 2002, the Maine Department of Transportation (MDOT), in cooperation with the Maine Turnpike Authority and New Hampshire Turnpike Authority contracted with Wilbur Smith Associates to examine the impacts resulting from the Turnpike federal weight exemptions.

Truck Weight Limits in Maine and New Hampshire

Weight laws pertaining to state highways in Maine, including that portion of the Maine Turnpike designated Interstate 95 and 495, are found in Title 29, Chapter 21 of Maine State Statutes. In Maine, the weight limits allowed on 5 and 6 axle combination vehicles depend upon whether the vehicle is carrying certain "special commodities" as defined in statute. The general and special commodity limits are outlined in **Exhibit 3.**

Vehicle weight laws for the State of New Hampshire are found in State Statues, Title XXI, Chapter 266 Sections 266:18-a, 266:18-b and 266:18-d deal specifically with weight limits allowed on Non-Interstate and General Highways. These limits are also show in **Exhibit 3.**

Exhibit 3: Maine & New Hampshire Weight Limits

	Maine		New Hampshire
Axle Configuration	Special	All Other	
Single axle limit	24,200 lbs.	22,400 lbs.	22,400 lbs.
Tandem axle limits			36,000 lbs.
5 axle combination	44,000 lbs.	38,000 lbs.	
6 axle combination	44,000 lbs.	41,000 lbs.	
Tri-axle weight limit			48,000 lbs.
5 axle combination	54,000 lbs.	48,000 lbs.	
6 axle combination	54,000 lbs.	50,000 lbs.	
GVW limit			
5 axle combination	88,000 lbs.	80,000 lbs.	84,000 lbs.
6 axle combination*	100,000 lbs	100,000 lbs.	99,000 lbs.

New Hampshire also requires that vehicles traveling at weights higher than those prescribed under federal limits be safety certified and pay additional registration. Certified vehicles "shall be considered to have reciprocity with other states granting New Hampshire similar reciprocity for the full weight limit designated in RSA 266:18-b or the weight limit for which the vehicle is registered, whichever is less."[2]

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* *Special Conditions of operation for 6 axle combination trucks in Maine*:

1) Special commodity 6 axle combinations may register for 90,000 lbs. and are allowed a weight tolerance to 100,000 lbs.; all others must register for 100,000 lbs..
2) The distance between the extreme axles, excluding the steering axle, must be at least 32 feet if carrying "special commodities" and at least 36 feet if carrying other commodities.
3) The distance between the steering axle and the first axle of the tandem must be at least 10 feet.

Study Approach and Report Organization

The primary objective for this study is to determine the safety consequences, infrastructure costs, as well as, social and economic impacts resulting from the exemption Congress provided from federal weight limits on the Maine Turnpike and New Hampshire Turnpike (ME/NH Turnpike). To conduct the analysis the current condition of allowing trucks in excess of 80,000 lbs. GVW on the ME/NH Turnpike is compared to a no-exemption scenario. The analysis concentrates on the projected safety and infrastructure impacts to state road networks that would assume heavy truck traffic if the current federal weight exemption is lifted from the ME/NH Turnpike. In presenting the results of this analysis, the report is organized as follows:

1. **Network Development:** Because the infrastructure and safety impacts analysis were based on the comparison of the base condition network (Turnpike exempt) and the study condition network (Turnpike not exempt), an understanding of the data used in modeling the networks is crucial to understanding the subsequent analyses. While some details about the network development are included as appendices to this report, additional documentation about the modeling process steps can be found in two Technical Memorandums prepared as interim reports during the course of this study.

2. **Safety Analysis:** The existence of a detailed, geo-coded crash database in Maine allowed the Study Team to examine the crash experience of five and six-axle vehicles across highway classes in Maine. Summary crash data for both Maine and New Hampshire is also presented within the context of the national crash experience for these vehicle types.

3. **Pavement Analysis:** Using TRANSEARCH data about heavy commodity flows, estimates of ton-miles and equivalent standard axel loads (ESALS) are modeled across the base condition network and the study network, to estimate the pavement costs associated with the weight exemption policy.

4. **Bridge Analysis:** The study analyzed a sample of representative bridges for Maine and New Hampshire and then examined the cost impacts across all bridges on the study networks.

5. **Other Economic and Social Impacts**: This section of the report presents an analysis of toll impacts, if vehicles above 80,000 lbs. GVW are not allowed on the ME/NH Turnpikes, and also presents the results of carrier and shipper interviews. This section also presents the findings of other prominent TS&W studies.

6. **Conclusions:** Summarizes the study findings.

Data Sources

Three principal data sources were used to understand existing truck traffic and estimate changes in truck flows due to a change in weight policy on the ME/NH Turnpike:

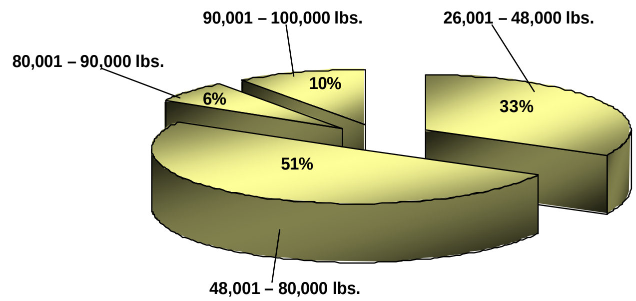
- TRANSEARCH commodity data
- Vehicle classification counts
- Weigh-in-motion (WIM) sites

These data were also supplemented with information from motor vehicle registrations, interviews with trucking firms, and information from weight enforcement officials.

Maine Registered Vehicle Weight

In 2002 there were 138,709 registered commercial vehicles in Maine. Nearly 90% of all registrations are single unit vehicles. More than half (57%) were registered for less than 26,000 lbs. Of the vehicles of 26,000 lbs. or more, only 3,262 (16%) were registered to exceed 80,000 lbs. These statistics reinforce that the vehicle population examined in this study represent only a fraction of the total truck population.

Commercial Vehicles Registered in the State of Maine for GVW of More than 26,000 pounds.



Source: Maine Bureau of Motor Vehicles

TRANSEARCH Commodity Data

TRANSEARCH is proprietary data, assembled and marketed by Reebie Associates since 1980, providing county level freight flows by mode and commodity. Considered the premier source for intercity and intra-city commodity flows, TRANSEARCH provides volumes and values by individual commodity and mode of transport throughout the U.S. Truck data are focused on the manufacturing industries, and are drawn from a sample of truck shipments by a number of major truckload and LTL carriers. The dataset used for this study reflected year 2000 commodity flows. The data covered all modes and commodities. Truck movements for non-manufactured commodities, typically a weakness of the TRANSEARCH data were enhanced for this study to capture flows of raw timber products.

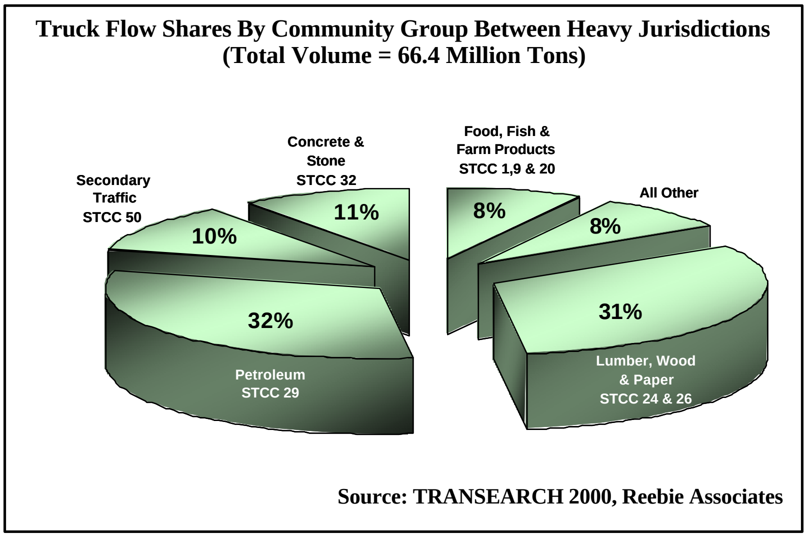
The first step of the analysis was to better understand existing commodity origin/destination (O/D) flows using the TRANSEARCH data. The analysis concentrated on "heavy commodity" flows to and from jurisdictions that allow GVW in excess of 80,000 lbs. in normal operations on state or provincial networks. The analysis also focused on "Special Commodities" as defined in Maine law.

The total volume of truck flows reflected in the TRANSEARCH dataset equaled 87.4 million tons. Extracting only those truck flows to and from jurisdictions allowing a GVW in excess of 80,000, (i.e., flows to and from Canada, New Hampshire, Massachusetts, New York and within Maine), resulted in 66.4 million tons, or roughly three-quarters of all truck flows by weight. It should be noted that these "high weight jurisdictions" may not allow higher truck weight on all facilities, but selected facilities in these other states or provinces, e.g. the New York Thruway allow GVW in excess of 80,000 lbs.

Exhibit 4 shows the resulting flows by commodity group. Five commodity groups comprise 92% of the "high weight jurisdiction" flows by truck:

- STCC 29 Petroleum Products
- STCC 24 & 26 Lumber, Wood & Paper Products
- STCC 32 Clay, Concrete & Stone
- STCC 50 Secondary Traffic
- STCC 1, 9 & 20 Food, Fish and Farm Products

Exhibit 4: Commodity Shares (tons)



More than 95% of Secondary Traffic moving in and through Maine is STCC 5010 traffic; mixed commodities moving between warehouse facilities. Typically, mixed commodities "cube-out" (i.e. they use the available volume capacity of the vehicle) before "weighing-out" (load to the legal GVW capacity) and for that reason STCC 50 traffic was not included among the heavy commodity groups. For additional simplification, several related commodity groups were combined and will be analyzed together.

The remaining combined commodity groups: 1) Petroleum; 2) Wood & Paper; 3) Concrete and Stone, and; 4) Food, Farm and Fish Products, became the focus of heavy truck flows later converted to 5 and 6 axle truck trips. Together, these commodity groups comprised more than 80% of the tonnage moving within Maine, or between and through Maine from other heavy truck jurisdictions. The top commodities resulting from the "gross weight highway jurisdiction" filter are Shown in the table of **Exhibit 5**.

Exhibit 5: Top Flows between Jurisdictions Allowing High Gross Vehicle Weights

STCC2	Commodity Group	Tons
29	Petroleum or Coal Products	21,051,444
24	Lumber or Wood Products	18,044,677
32	Clay, Concrete, Glass or Stone	7,233,870
50	Secondary Traffic	6,768,652
20	Food or Kindred Products	4,147,817
26	Pulp, Paper or Allied Products	2,611,756
14	Nonmetallic Minerals	1,572,526
28	Chemicals or Allied Products	1,129,204
34	Fabricated Metal Products	868,926
1	Farm Products	724,813

Special Commodities

As discussed earlier, the State of Maine allows a 10% weight allowance on 5-axle tractor semi-trailer (TST) combinations. Special commodities are defined as:

- Materials or unset concrete intended for highway construction and carried in dump or transit-mix trucks;
- Manufacturer's concrete products;
- Raw ore from mine or quarry to place of processing;
- Unprocessed milk;
- Refrigerated products constituting the majority of products carried in a sealed vehicle;
- Building materials that absorb moisture during delivery with O/Ds within the State;
- Incinerator ash;
- Unconsolidated rock materials, including limestone, bark, bolts, sawed lumber, farm produce, road salt, soils, solid waste, sawdust, wood chips, dimension lumber, recyclable, materials, pulpwood/ firewood/logs.

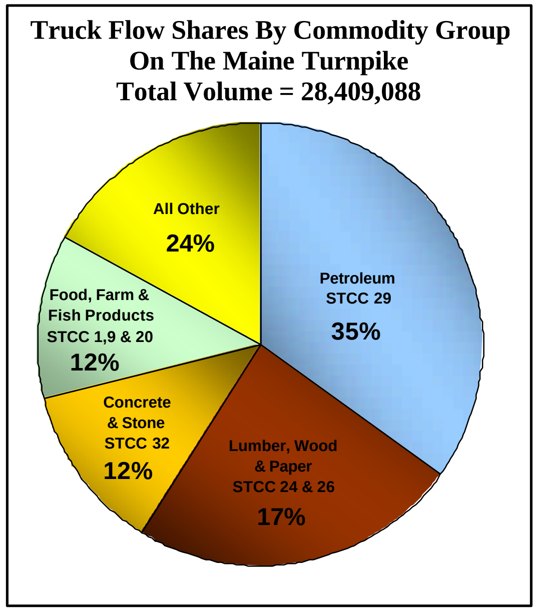
Specific commodity types within four high-weight commodity groups were also examined and filtered to determine those products that would likely qualify for the five axle GVW bonus allowed for “special commodities.” The resulting special commodity list in **Exhibit 6** was used in selecting heavy weight commodities later modeled to the study network:

Exhibit 6: “Special Commodities” Extracted from TRANSEARCH

o Concrete products	o Maine Products
o Portland Cement	o Fresh Fish or Whale Products
o Broken stone or riprap	o Frozen Fruit, Vegetables or Juice
o Gravel or sand	o Frozen Specialties
o Dimension Stone, Quarry	o Ice, Natural or Manufactured
o Clay, Ceramic Minerals	o Forest Products
o Fertilizer Minerals – Crude	o Primary Forest Materials
o Misc. Non-metallic Minerals	o Lumber or Dimension Stock
o Clay, Brick or Tile	o Misc. Sawmill
o Ceramic Floor or Wall Tile	o Millwork
o Meat, Fresh or Chilled	o Plywood or Veneer
o Meat, Fresh Frozen	o Structural Wood Products
o Meat Products	o Treated Wood Products
o Dressed Poultry, Fresh	o Misc. Wood Products
o Dressed Poultry, Frozen	o Pulp or Pulp Mill Products
o Processed Poultry or Eggs	o Fiber, Paper or Pulp board
o Creamery Butter	o Pressed or Molded Pulp Products
o Ice Cream or Frozen Desserts	o Paper or Building Board
o Cheese or Special Dairy Products	o Ashes
o Processed Milk	o Metal Scrap or Tailings
o Processed Fish	o Paper Waste or Scrap

After filtering the data by high weight jurisdiction O/Ds and commodity type, the dataset was used to distribute heavy truck trips on Turnpike sections of I-95 in Maine and New Hampshire. A least travel time algorithm was applied and all flows were assigned to the ME/NH Turnpike.

Exhibit 7: Maine Turnpike Flows

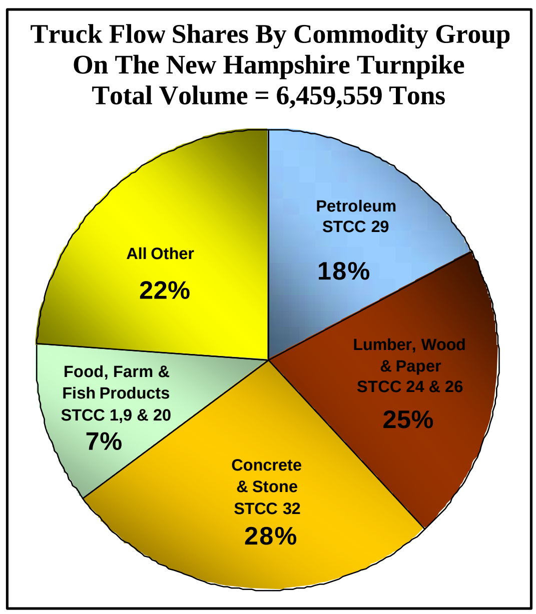


In developing the base scenario reflecting current weight policy, the network assignment algorithm was used to load all truck flows to the ME/NH Turnpike and parallel routes were "turned-off." As a result, for any O/D pair requiring a north/south routing through Maine or south eastern New Hampshire, the ME/NH Turnpike is treated as the only available route**.**

The chart in **Exhibit 7** displays the weight shares by commodity group for flows routed to the Maine Turnpike. The total volume of commodities was 28.4 million tons.

The chart in **Exhibit 8** displays the relative weight shares by commodity group for commodity flows routed to the New Hampshire Turnpike, with a total volume of nearly 6.5 million tons. *It must be noted that these flows do not include origins from New Hampshire. The TRANSEARCH dataset purchase included only O/Ds trips to and from Maine. Therefore, the data presented is primarily of flows passing through or destined to New Hampshire.*

Exhibit 8: New Hampshire Turnpike Flows



A final filter removed *most* intra-county movements. The filter is based on the expectation that most movements contained wholly within a single county would not be greatly impacted by a policy change on the ME/NH Turnpike. (Intra-county tons that would likely use the Turnpike were identified for York and Cumberland counties). A summary of TRANSEARCH tonnages applied to the ME/NH Turnpike are shown in **Exhibit 9.**

Exhibit 9: Summary of TRANSEARCH data

TRANSEARCH scenario	Records	Total of ALL Tons	Total of HWT Tons
All Maine Traffic	96,400	**87,355,609**	21,860,386
W/O intra-county	96,295	81,818,116	17,425,592
Turnpike only	74,359	57,642,762	**7,115,216**

Exhibit 10 provides a sample of the STCC exempt-load commodity classifications used in the filtering and the associated tonnages for all flows to, from, and within Maine (the column "ALL tons"). And, the flow tonnages modeled as using or potentially using a route that includes Maine-New Hampshire Turnpike (the column "HWT

flows on the Turnpike"). Tonnages from a total of 48 commodity classes were used in the final modeling process.

Exhibit 10: Top Heavy Commodities and Associated Tonnages

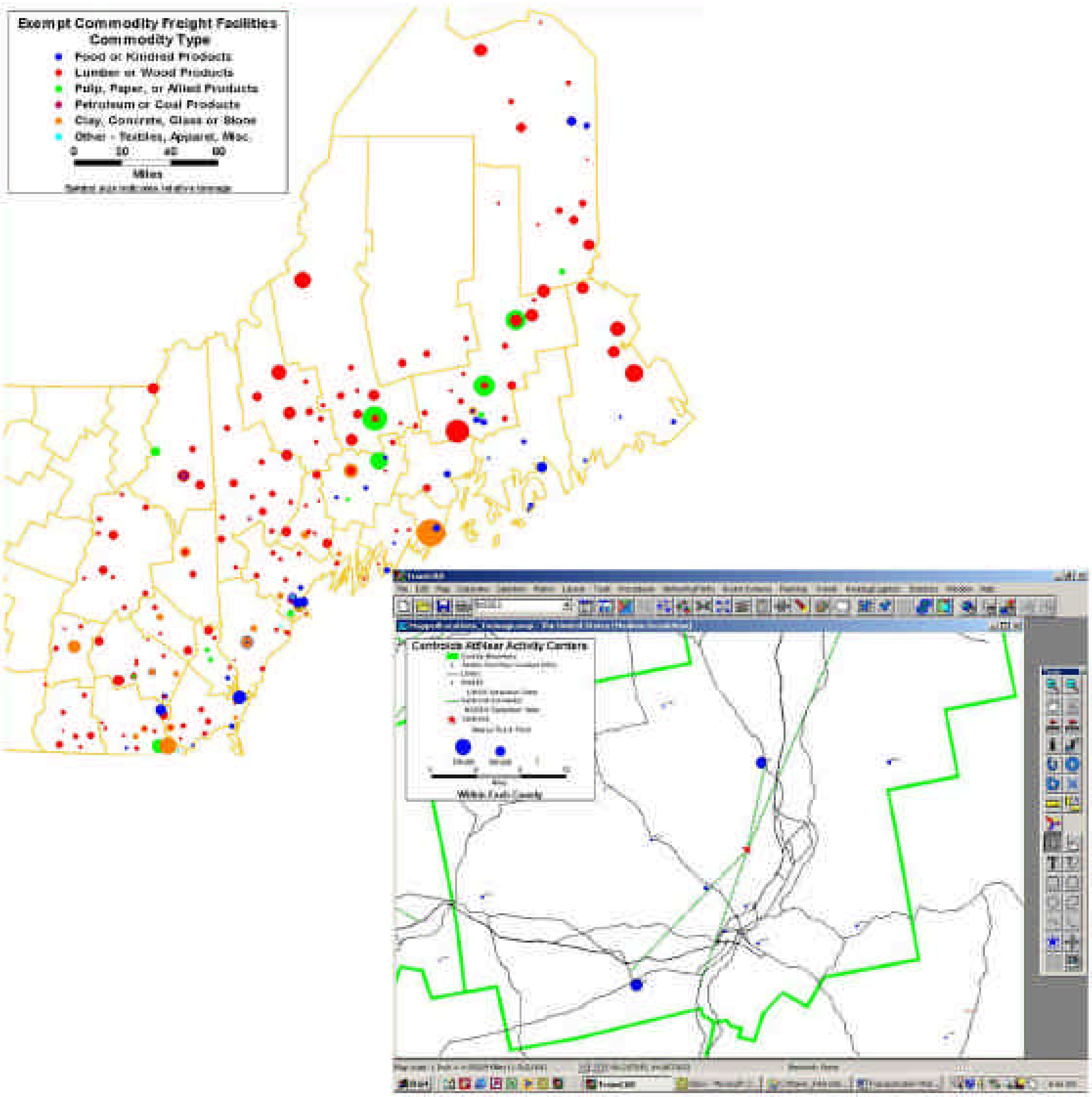
STCC4	Commodity Description	ALL Maine flows		HWT flows on the Turnpike		
		ALL lanes	ALL tons	HWT lanes	HWT Tons	HWT Rank
2411	Primary Forest Materials	1175	15,390,074	275	1,388,498	1
2421	Lumber Or Dimension Stock	2667	1,759,785	418	550,032	2
3271	Concrete Products	668	1,127,162	226	529,647	3
2611	Pulp Or Pulp Mill Products	712	1,110,785	206	509,845	4
2026	Processed Milk	520	667,635	234	413,465	5
2661	Paper Or Building Board	783	2,372,544	171	390,708	6
2499	Misc Wood Products	2046	668,479	344	190,182	7
2097	Ice, Natural Or Manufactured	354	308,251	119	166,878	8
119	Misc. Field Crops	1109	1,400,963	187	128,302	9
3241	Portland Cement	352	327,979	104	107,707	10

TRANSEARCH Freight Facility Information

An element of the commodity data purchased by the State of Maine, included a data set containing the location of major industrial facilities. The *Freight Locator Database* data originates from industrial location data that Reebie purchases from *infoUSA* and uses to formulate commodity origins and destinations in creating the TRANSEARCH database. The facility data supplied included facilities in both Maine and New Hampshire and could be matched against the types of commodities they produce or receive. Facilities potentially receiving or producing products in exempt commodity groups were then identified.

The map in **Exhibit 11** illustrates facilities handling exempt weight commodities with an influence on traffic using the ME/NH Turnpike. The map markers for these facilities are scaled by their approximate annual truck freight tonnage for the exempt commodities. These facilities were added to the TransCAD model as freight generators. The facility locations were used to refine the freight flows in the analysis of the diversion network, where the county-level flows reported by TRANSEARCH do not provide sufficient detail (i.e. where there are many possible route options within the county). To assign traffic flows from one county to another, the counties (i.e. zones) were connected to the network. To replicate vehicle travel, "centroids" near county activity centers were assigned to each zone. The activity centers were based on the actual locations of these freight facilities, including intermodal facilities and other commodity depots identified in the Freight Locator data. **Exhibit 11** also shows the TransCAD screen used in linking centroids to the network.

Exhibit 11: Freight Facility Locations and Centroid Assignment



Converting Commodity Volumes to Truck Counts

Theoretically, with a GVW limit of 88,000 lbs. a fully loaded 5-axle TST combination can carry a payload of approximately 57,000 lbs.. With a GVW of 100,000 lbs., a six-axle TST combination can carry a payload of approximately 68,000 lbs..

To estimate truck counts hauling heavy commodities on the ME/NH Turnpike Sections of I-95, both the national payload averages used in TRANSEARCH, and the theoretical payload averages for 5 and 6 axle TST combination trucks were examined. Using a conservative approach, the theoretical truck counts were later distributed across the study network in the modeling process.* The resulting truck counts for each payload factor are shown for the Maine Turnpike in the table of **Exhibit 12**. Results for the New Hampshire Turnpike appear in **Exhibit 13:**

Exhibit 12: Truck Count Estimates – ME Turnpike

Commodity Group	Total Truck Tons	Truck Count Theoretical 5-Axle	Truck Count Theoretical 6-Axle
Petroleum & Coal Products	9,972,347	349,907	293,304
Lumber, Wood & Paper Prods.	3,251,083	114,073	95,620
Food & Fish Products	1,199,238	42,079	35,272
Stone & Concrete Products	685,156	24,041	20,152
Total	**15,107,824**	**530,099**	**444,348**

Exhibit 13: Truck Count Estimates – NH Turnpike

Commodity Group	Total Truck Tons	Truck Count Theoretical 5-Axle	Truck Count Theoretical 6-Axle
Petroleum & Coal	61,361	2,454	1,805
Concrete & Stone	140,815	5,633	4,142
Wood & Paper	117,512	4,700	3,456
Totals	**319,688**	**12,787**	**9,403**

Weigh-in-Motion (WIM) data

Network development for the study also entailed an analysis of existing weigh-in-motion data from Maine and New Hampshire. For this study, data was taken from two WIM stations located on the turnpike in Maine and one WIM station on the turnpike in New Hampshire. Data was also available from eight non-turnpike WIM stations in Maine that were used for network calibration.

WIM stations record a variety of statistics for each vehicle passing over sensors imbedded in the pavement, including:

- Number of axles;
- GVW (GVW);
- A calculation of *equivalent standard axle load* (ESAL);
- Vehicle speed.

The WIM stations in Maine and New Hampshire were installed early in 2001. For this analysis records for every vehicle with 5 or more axles were extracted. The total number of records exceeded 8 million for Maine (for all ten Maine stations) and nearly 2.5 million for New Hampshire. The WIM records for vehicles with 5 or more axles were imported into an ACCESS

* A weigh sample of empty 6-axle TST vehicles by the Maine State Patrol found a wide range of tare weights. The theoretical tare weight used here is based on figures from the USDOT Comprehensive Size and Weight Study, and phone calls to semi-trailer manufacturers. The tare weights used also fell within the average empty vehicle weights for 5 and 6-axle trucks detected at Maine WIM stations.

database and the most recent complete year of data was analyzed for each station. Average annual daily values were then derived. **Appendix A** presents detailed data summaries for each WIM station.

Observations from the WIM Data:

1. Turnpike stations had the highest traffic volumes for all WIM stations examined. The New Hampshire Turnpike station had the highest 5 and 6 axle truck volumes.

2. Trucks operating in the exempt weight ranges (80,000 – 100,000 lbs.) accounted for about one-third the cumulative ESAL calculations. The ESAL estimates from WIM stations at the southern end of the turnpike are dominantly a south directional flow for all 5 and 6 axle truck traffic, including higher-weight traffic.

3. A high proportion of the vehicles recorded in exempt weight ranges by Turnpike WIM stations are 5 axle trucks. The total ESAL estimates for vehicles at and above exempt weight limits, is roughly equal for 5 axle vehicles and for 6 axle vehicles. A significant proportion of the cumulative ESAL estimates for six axle vehicles result from vehicles traveling at weights above 100,000 lbs.

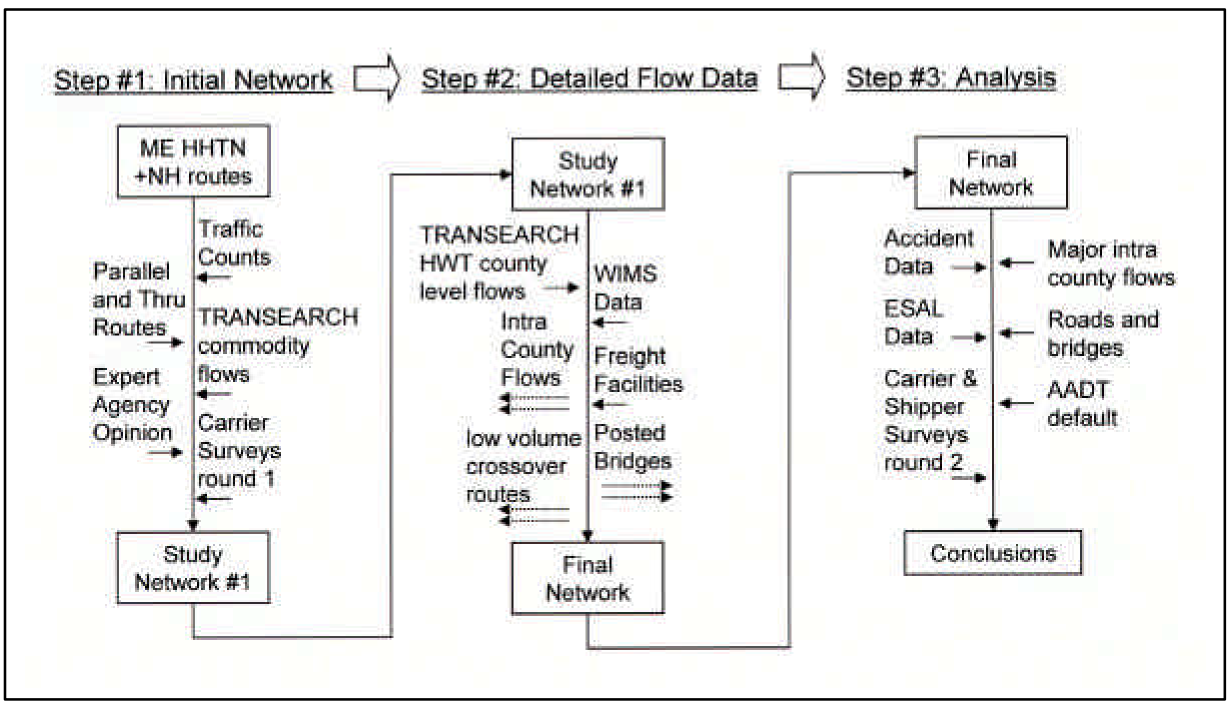
4. It is assumed that vehicles over exempt weights (above 88,001 lbs. for a 5 axle truck, or above 100,001 lbs. for a six axle truck, both indicated as 'over exempt wt' in the Exhibits), are traveling under special permits and would continue on these same routes even if general weight laws changed. However, the implications of this assumption should be carefully considered, since these vehicles account for very high proportions of total ESAL loadings.

Study Network Modeling Process

If the current weight exemptions on the Maine and New Hampshire Turnpikes were rescinded, it is expected that there would be a *reduction* in 5 and 6 axle combination trucks, hauling loads between 80,000 and 100,000 lbs. GVW (exempt weights), on Turnpike facilities. Since it is assumed that existing weight policy on State Highways would remain unaffected, state routes would be expected to experience a *net increase* in traffic. *The set of roads on which truck traffic is expected to change, as a result of the change in policy, is defined as the* ***Study Network***. The *Study Network* was developed through truck count and commodity flow data, expert opinion, carrier interviews and a modeling process employing TransCAD software. Some roadways included in the *Study Network* serve primarily as connectors to the Turnpike; these connector routes could see *reductions* in traffic, since some traffic would no longer use these connections to access the Turnpike.

The Maine network was developed using the road geography from the TIDE database maintained by MDOT. The network for New Hampshire used traffic count data in the NHDOT SmartMap. All data were imported into a road network using TransCAD GIS modeling software. The modeling process allowed specific groups of roadway links to be "enabled" or "disabled" to evaluate different weight policies. The truck traffic flows assigned to the network were derived from the TRANSEARCH commodity tonnages. These assignments were calibrated against vehicle counts received from vehicle classification station counts. The flow diagram in **Exhibit 14** shows the iterative process used in modeling and defining the *Study Network*.

Exhibit 14: Flow Diagram of the Study Network Development Process†



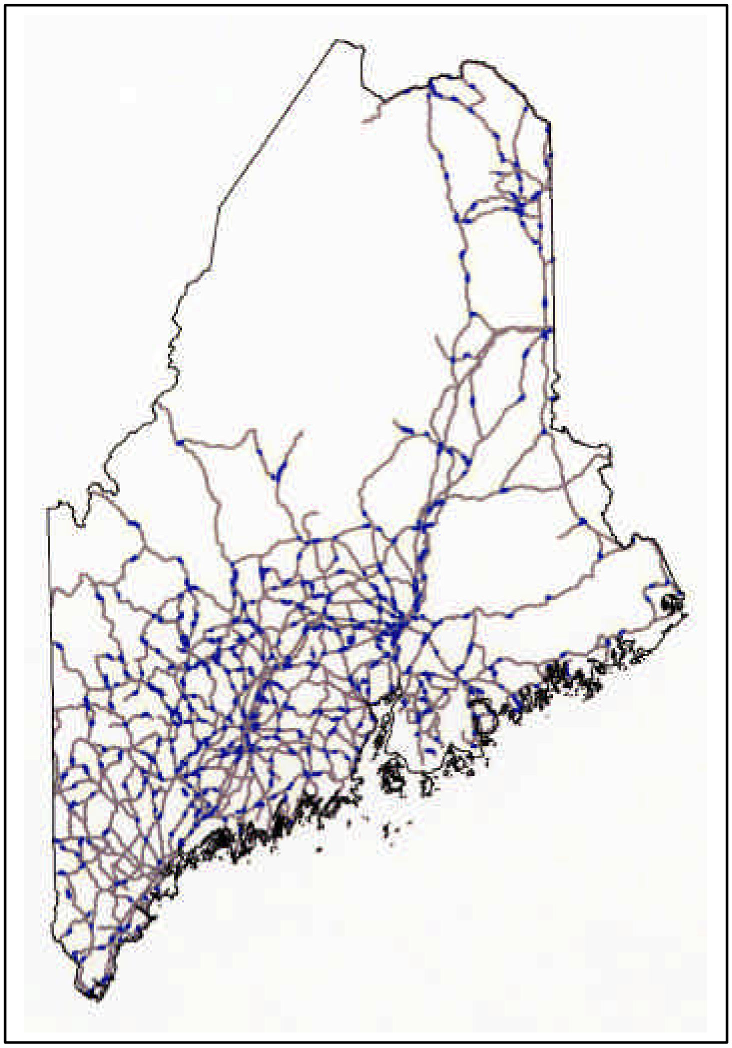
† Diagram Abbreviations: HHTN = Heavy Haul Truck Network, AADT = Average Annual Daily Traffic

Routing Assumptions

The network assignment process started with three key routing assumptions. These assumptions were applied to a set of Maine roads defined by the Maine Heavy Haul Truck Network (HHTN) and a similar network for the State of New Hampshire. In 2001 the Maine Department of Transport contracted a study to identify roadway facilities that carry the majority of truck traffic across the state. As a result, one of the assumptions of "non-exempt Turnpike" scenario, was that diversion routes within the State of Maine would be on a subset of the Heavy-Haul Truck Network (HHTN).[3] The HHTN Study:

- Identified a network of Maine roadways where truck traffic is most intensive;
- Identified physical deficiencies along these roadways; and
- Determined the type and cost of improvements that best address these deficiencies.

Exhibit 15: MDOT-Vehicle Class Count Stations



The HHTN was developed using truck distribution data take from 842 vehicle classification stations maintained by MDOT (**Exhibit 15**). Since many of the same data sources and techniques were used for this study, were also used in HHTN study.

Assumption 1: Heavy Haul Truck Routes: The Maine network would be a subset of the Maine Heavy Haul Truck Network (HHTN). Although a defined HHTN was not available for New Hampshire, similar criteria were applied to develop a similar road network.

Facilities classified as *Principal Arterials* were included in the HHTN by default, as were NHS facilities classified *Intermodal Connectors.* Other facilities were designated for inclusion on the HHTN based on the following criteria:

- A threshold ESAL value;
- System continuity and rationality.
- Input from the HHTN Study Committee, Regional Advisory Councils and Division Engineers;
- Connectivity with intermodal terminals, water ports, airports and major border crossings

Assumption 2: Parallel Routes: Truck drivers will choose the most time efficient route between origin and destination. As available routes change due to a change in regulatory policy, freight will continue to move between the same market areas and use *the next most time efficient routes, which will broadly parallel the original routes.*

Assumption 3: Long-Distance Through Routes: The overall network must be able to carry through-traffic between distant points such as between Northern New England States and Canada.

For the Maine HHTN Study commercial vehicle counts were prorated across the entire state highway network wherever truck values were unknown. Unknown values were calculated by weighting the percentage of average annual daily traffic (AADT) for each truck class by the distance of the "unknown" link. For this study, the actual number of trucks in each class, (rather than percent) adjacent to unknown links was used as to prorate ESAL estimates. The modification was made to reduce the potential for error in calculating urban area ESALS.

The NHDOT SmartMap

The NHDOT is responsible for maintaining an inventory of every publicly owned road, street, and highway in the state. The inventory contains numerous fields of physical characteristics such as number of lanes, lane width, pavement type, and street name, as well as administrative characteristics such as functional classification owner, access control, and maintenance responsibility. SmartMap is an intelligent map maintained as an ArcView shapefile generated from the NHDOT Road Inventory database. Each graphic entity carries a select subset of the road inventory information as attributes. Periodically, as the Road Inventory database is updated and corrected, a new 'snapshot' of the database is taken to keep the maps and attributes current.

Functional class and surface type are included in the SmartMap system. A combination of this information, traffic count and classification data from NHDOT, and expert opinion was used to develop an NH counterpart to the Maine HHTN for the parts of the NH road network needed for this study.

Carrier Survey of O/D's and Primary Routes

As a reality check on the modeling process, a series of phone interviews were conducted with trucking companies to learn about their routing decisions. Details from the survey process are presented in **Appendix B.**

The Final Study Network

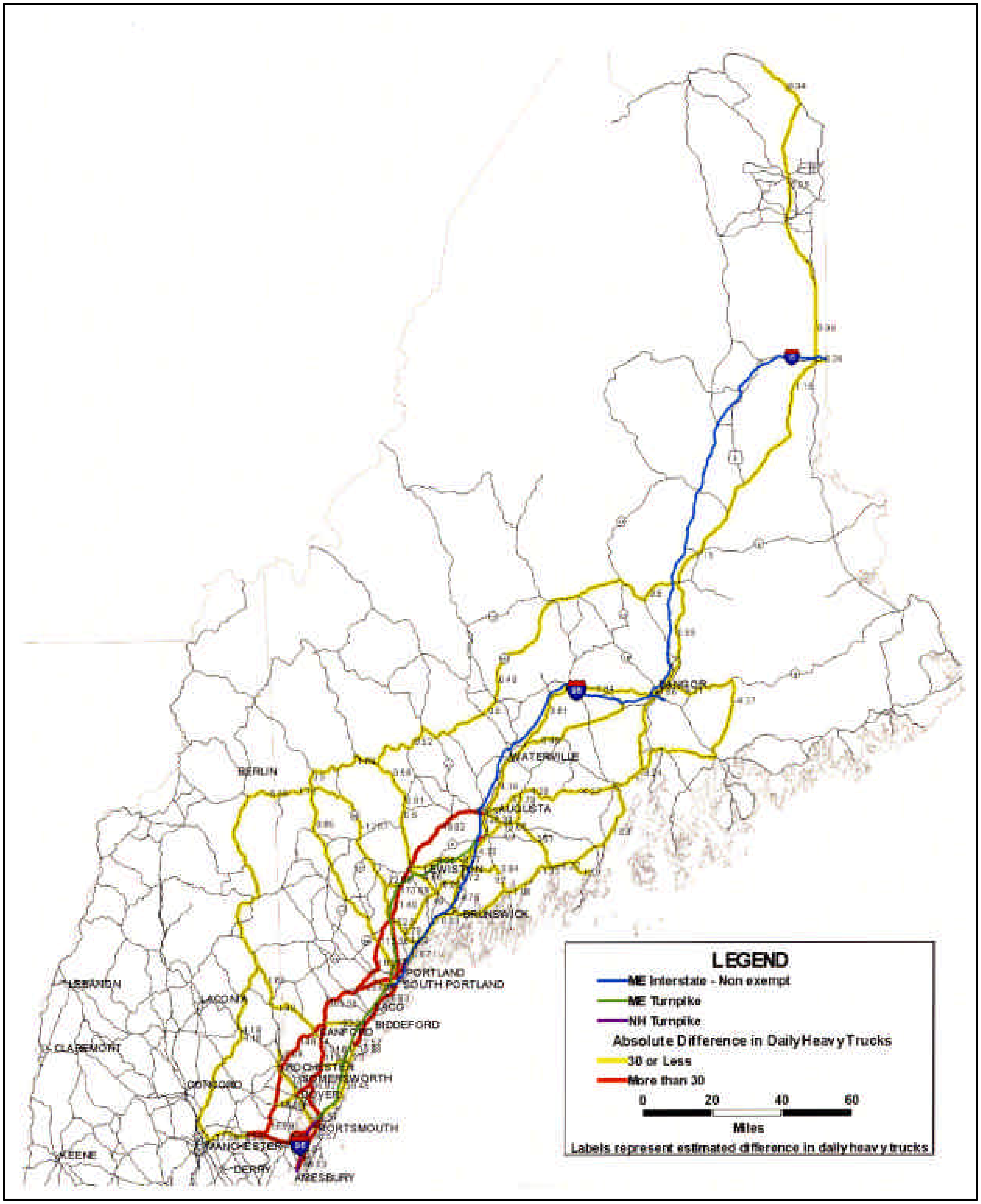
The table in **Exhibit 16** shows the summary mileage of the non-Turnpike road types (diversion routes) in the Study Network. The TransCAD model used for the analysis stores road segments with much greater detail, including many short 'connectors' (on-ramps., etc.) that are not reflected in the summary data.

Exhibit 16: Study Network Miles by Functional Class

Total Mileage	State		Grand
Functional Class	**ME**	**NH**	**Total**
Local and Other	9.0	7.5	16.5
Major Urban Collector	270.0	6.68	276.7
Minor Arterial	449.2	45.9	495.1
Principal Arterial	437.5	225.0	662.5
Grand Total	**1,165.7**	**285.1**	**1,450.8**

The map in **Exhibit 17** shows the network used in analyzing safety and infrastructure impacts.

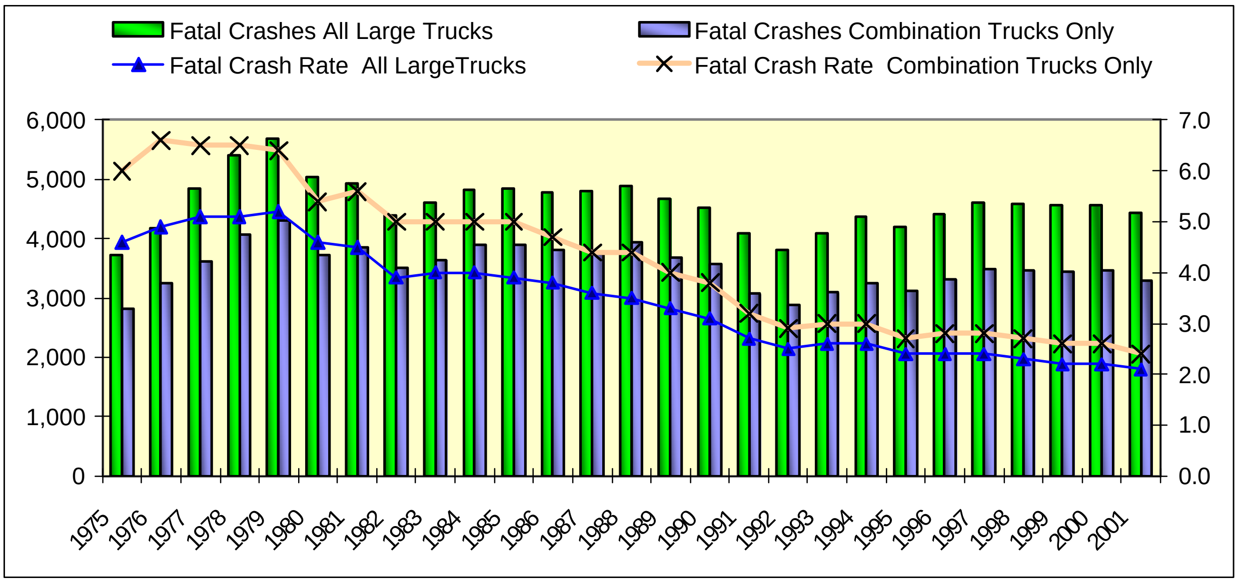
Exhibit 17: Final Study Network



Safety Analysis

Nationally, fatal crash involvements for all commercial vehicle types have held relatively steady over the past several years, but the rate of large trucks involved in a fatal crashes has shown a steady decline over two decades, declining 52% between 1981 and 2001. In 2000, large trucks (GVW rating greater than 10,000 lbs.) were involved in 456,930 traffic crashes in the United States. Of this total 4,573 were fatal crashes in which 5,282 people died.[4] In 2001, the number of fatal crashes and fatalities involving large trucks declined slightly to 4,431 and 5,082 respectively. In 2001, an additional 131,000 people were injured in crashes involving large trucks. Of all motor vehicle fatalities across the U.S. in 2001, fatalities from crashes involving a large truck represented 12 percent of the total.

Exhibit 18: National Fatal Crash Trends for Large Trucks



In **Exhibit 18,** the bar graphs show the trends in fatal crashes involving all large trucks and combination trucks over the past 25 years.[‡] The line graphs depict fatal crash rates: crashes per 100 million vehicle miles of travel (VMT). Since 1981, large truck VMT has grown 91%, and as a result crash rates have shown a steady decline. The fatal crash rate for combination trucks has shown an even more dramatic decline, and in 2001 was roughly one-third what it was in 1976.

[‡] Large trucks are defined as a truck with a GVW rating (GVWR) greater than 10,000 lbs.. Combination trucks are defined as a truck tractor pulling any number of trailers (including none) or a straight truck pulling at least one trailer.

Geo-coded Truck Crash Analysis on the Maine Portion of the Study Network

In creating the *Study Network* previously described, it was recognized that geo-coded crash data was available from the MDOT that could be analyzed by road type. (Comparable crash data was not available for New Hampshire. Records about truck crashes that were available for New Hampshire are examined later in this section). A previous study of truck size and weight noted a strong correlation between crash rates and functional highway class:

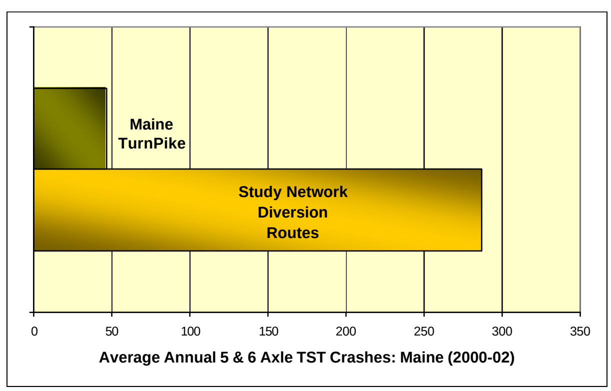
> *"Numerous analyses of crash data bases have noted that truck travel, as well as all vehicle travel, on lower standard roads (that is, undivided, higher speed limit roads with many intersections and entrances) significantly increases crash risks compared to travel on Interstate and other high quality roadways. The majority of fatal crashes involving trucks occur on highways with lower standards…. The [fatal crash] involvement rate on rural Interstate highways is 300 percent to 400 percent lower than it is on other rural roadway types and is generally the same for all vehicle types."*[5]

The geo-coded crash analysis divides the road segments of the study network into 2 groups of roadway facilities (note that *each study network segment is in one, and only one, group*):

- **Maine Turnpike**: Controlled-access facilities expected to lose traffic under the study scenario (non-exempt). The dataset consists of 242 centerline miles of two or more lanes running in the same direction.
- **Diversion routes**: Constituted the remainder of the *study network*. Non-interstate routes expected to gain traffic, under the study scenario.[§] The diversion road set consisted of 4,540 centerline miles of primarily two lanes, each running in opposite traffic directions.

As only Maine crash data was available in a geo-coded format, only Maine portions of the study network were used to estimate crash rates for 5 and 6 axle TST vehicles. The purpose of this exercise was to compare TST crash rates on controlled access Interstate-level facilities, to other roadway classes. The geo-coded crash analysis was conducted in three major steps:

Exhibit 19: Annual Network TST Crashes

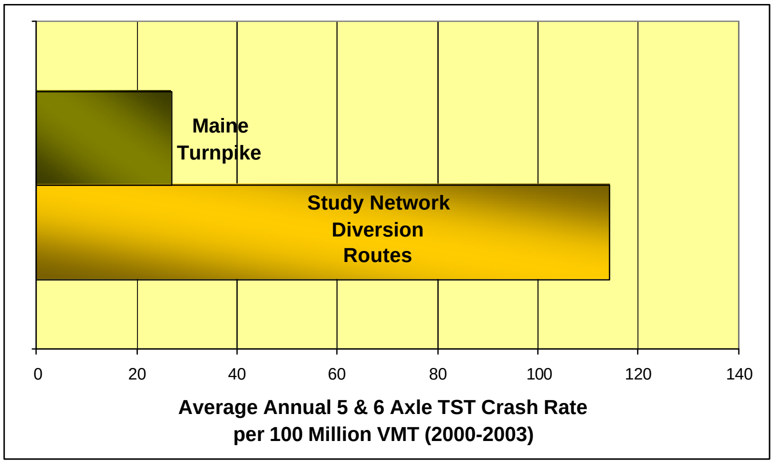


1. **Develop crash records with matching route and vehicle criteria:** Geo-coded crash data were filtered by recorded vehicle type to extract only crashes involving 5 or 6 axle TST combination vehicles, with GVW registrations of 80,000 lbs. or more. Next only crashes occurring on some portion of the *study network* (Turnpike or diversion routes) were extracted. A total of 1,000 crashes from the three years of data passed both filters to constitute the sample population. **Exhibit 19** shows the annualized number of 5 and 6 axle TST crashes on the Maine Turnpike, and *study network* "diversion" routes.

[§]*Note: the diversion network does not include non-exempt portions of the Maine Interstate System.*

An "economic impact" associated with each type of crash was also included in the MDOT crash records. The calculated economic impacts were based on standard values using the number of damaged vehicles and personal injury or death. The total calculated economic impact from all 1,000 crashes was $70,036,000. The annualized economic impact attributed to the two roadway sets is show in **Exhibit 20.**

Exhibit 20: Annual Economic Impacts – TST Crashes



2. **Derivation of *Study Network* VMT:** Road segments in the *study network* contain estimates of 5 and 6 axle TST –AADT for many *but not all* segments. For each segment with known TST-AADT: TST counts were multiplied by length of the segment; summed; and, divided by the total of all known AADT segment lengths, to produce an average TST-AADT. The averages based on the known-AADT segments were 2,226 AADT for the Maine Turnpike, and 151 AADT on "diversion" roadways. The average TST-AADT counts from known segments were then multiplied by total miles (including segments with *unknown* TST AADT) to produce "*length adjusted VMT*". These steps resulted in annual VMT estimates of 1.73 (expressed in 100-million VMT) on the "Maine Turnpike, and 2.51 on the "diversion" roadways.

The procedure used in deriving VMT estimates for diversion routes of the study is expected to result in *overestimated* VMT, as missing AADT counts on secondary routes are typically segments with low traffic. To some extent the opposite affect is expected on interstate level facilities: i.e., missing AADT counts on controlled-access roads segments are typically segments with multiple entry and exit points, such as urban areas, which often experience higher traffic levels. To the extent that this occurs, Turnpike AADT may be underestimated on controlled access roads. To correct for this, an *attenuation procedure* was applied that applied only 75% of the VMT increase from "known" to "length-adjusted" VMT.

The *net effect* of the two procedures is expected to result in crash rates relatively more favorable toward diversion routes, than would b e expected if actual VMT were known for every road segment. Since the diversion roads are generally expected to have the higher crash rates, the effect is considered a conservative approach when comparing the crash rates: the error will be towards indicating smaller crash rate differences (between controlled access roads and other road types), rather than larger.

Exhibit 21: *Study Network* TST Crash Rates

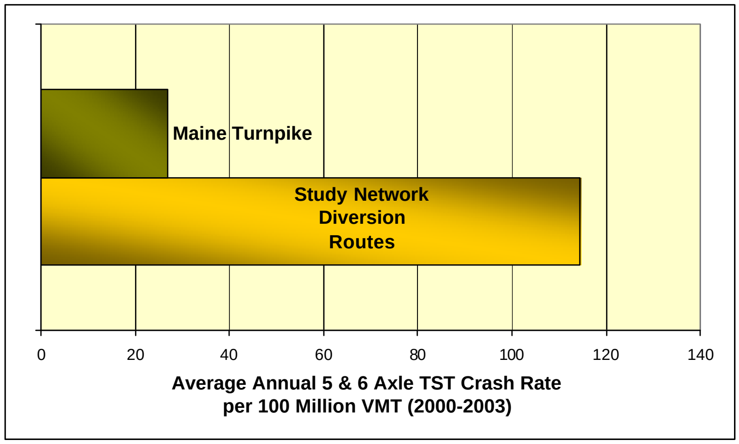


Exhibit 21 shows the resulting average annual crash rates for 5 and 6 axle TST combination vehicles on the Maine Turnpike and on all other study network routes.**

3. **Forecast net change in crashes:** As noted in the network development discussion, estimates of ton-mile flows for exempt commodities were distributed to the *study network*, using commodity volume data and the flows were then converted to truck vehicle miles. The forecasted changes in VMT under the study condition were multiplied by the overall crash rates and associated economic impacts derived in the crash analysis to estimate the annual change in number of crashes and associated economic impacts.

Geo-code Crash Analysis Results: The three step analysis provides a series of comparative statistics for each functional class of highway contained in the study network Graphics examining some of the factors associated with TST crashes in Maine such as: Crash type and injury levels are shown and briefly discussed on this and the next page. ***All crash rates are annual averages expressed in crashes per 100 million vehicle miles of travel***

Exhibit 22: Avg. Annual TST Crash Rates by Highway Type

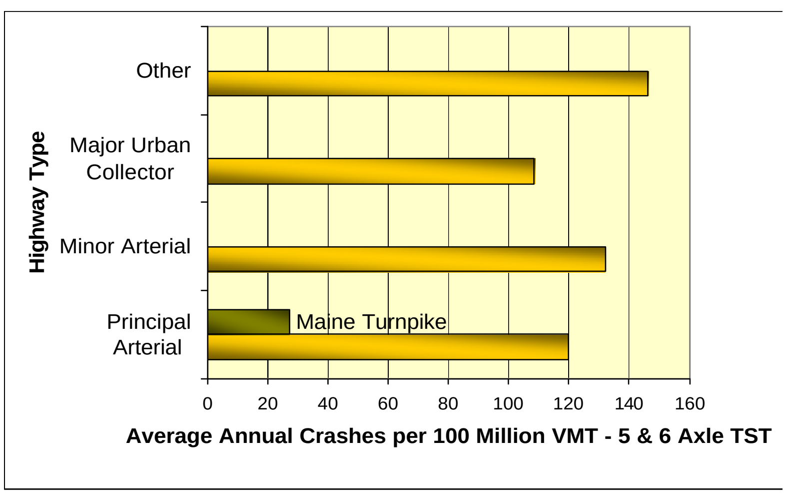


Exhibit 22 shows the crash rates derived for 5 and 6 axle TST combinations on the study network by functional highway class. The crash rate per 100 million VMT (HMVMT) for the Maine Turnpike is approximately 26/HMVMT. The crash rate for each of highway type in the study network including other principal arterials is at least 4 times higher than the Turnpike TST crash rate.

** Crash counts and rates are based upon "vehicle involvement" where each truck was counted as one "involvement". Thus a single crash involving two trucks would count as "two involvements" for the reported crash counts and rates. Crashes involving multiple trucks were approximately 1% of the total.

Exhibit 23: Study Network Crash Rates by Crash Type

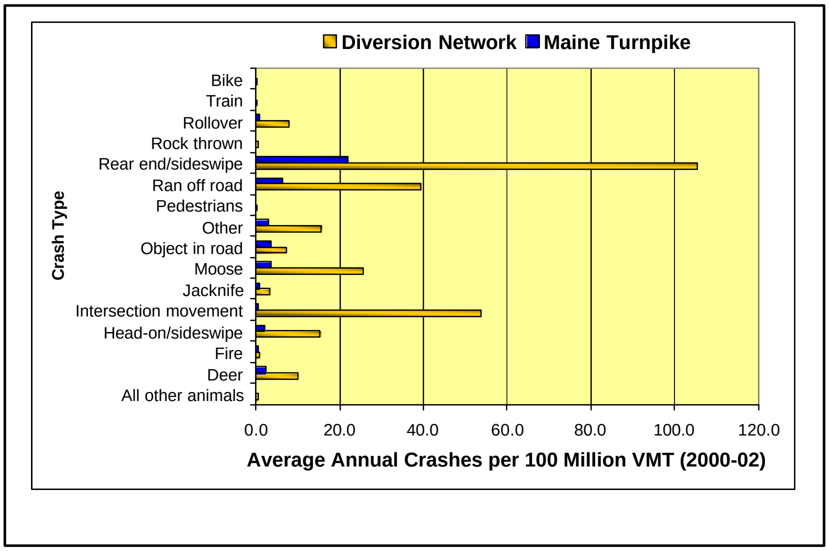


Exhibit 23 displays the results of comparing 5 and 6 axle TST crash rates on the Maine Turnpike to the diversion road set. While crash rates on diversion highways are higher for all crash types, in particular *intersection movement*, *head-on side-swipe*, and *read-end side-swipe* are all dramatically more prominent. This finding is not surprising as most roadways in the diversion network are two lane highways with at-grade intersections, while the Turnpike is a controlled access, divided highway with four or more lanes.

Exhibit 24: Study Network Crash Rate by Injury Level

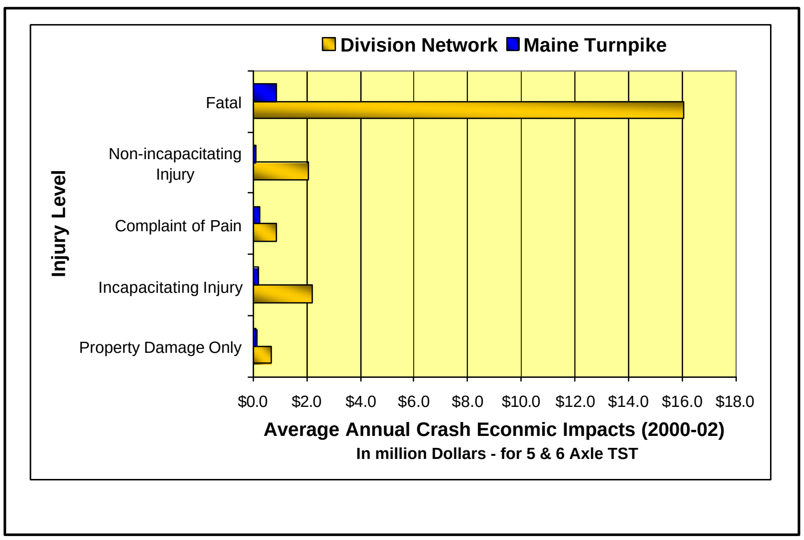
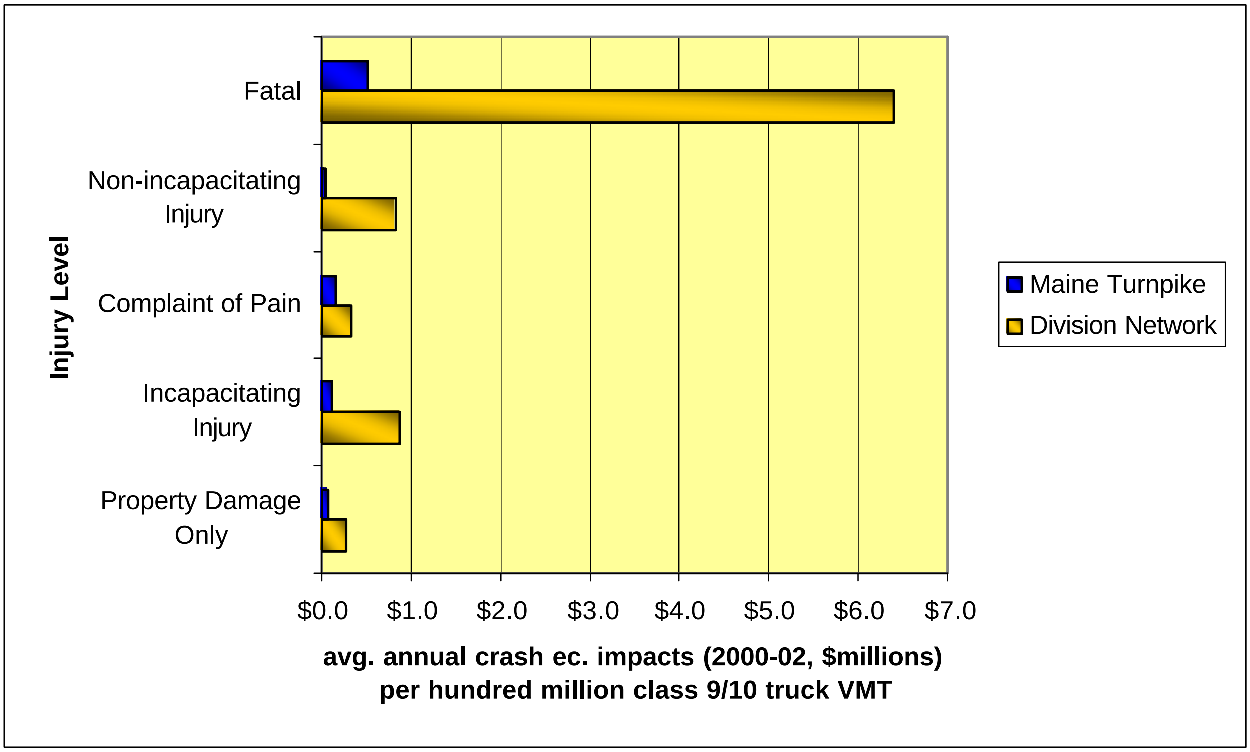


Exhibit 24 displays crash rates for the Maine Turnpike and diversion routes by severity of the crash.

The fatal TST crash rate of 0.2/ HMVMT for the Maine Turnpike is not visible in the graphic, but the TST fatal crash rate of 1.9/HMVMT on the diversion road set is nearly 10 times higher than the rate on the Turnpike. The "incapacitating injury" TST crash rate on the diversion network is nearly seven times more prevalent than the crash rate on the Turnpike.

Exhibit 25 shows the economic costs associated with injury severity for the Maine Turnpike and the diversion routes of the study network. Fatal crashes involving 5 and 6 axle TST combinations on the diversion network are estimated to carry an associated impact of $16 million. All crash types on the diversion network carry an associated impact of $21.8 million.

Exhibit 25: Economic Impacts for Crashes by Severity



The safety analysis indicates that if Congress were to remove the current weight exemption on the Maine Turnpike the net impact for Maine would be an increase of 5.0 crashes annually. The FHWA defined economic impacts would be $443,000 per year.

For the New Hampshire safety analysis, the crash rates by functional highway class developed from the crash experience in Maine were applied to the expected changes in New Hampshire TST truck traffic by functional class on the modeled study network. **The analysis indicates that removal of the federal weight exemption on the New Hampshire Turnpike would result in a net increase of 1.2 crashes per year in New Hampshire, or an economic impact of $98,000 per year.**

Comparative Analysis of Truck Crashes by State

In addition to the geo-coded crash rate analysis of TST crashes in Maine, the study team also examined fatal truck crashes across all states to gain an understanding of the relative safety environment for commercial vehicles in Maine and New Hampshire as compared to other jurisdictions.

The study team used records from the University of Michigan Transportation Research Institute (UMTRI), "*Trucks Involved in Fatal Accidents*" (TIFA) files. Fatal semi-truck crashes were extracted for a 5 year period (1996 – 2000). Using only fatal crashes held an advantage of having a higher degree of consistency in reporting across states and years. **Exhibit 26** contains the table of state comparison statistics. Between 1996 and 2000, Maine averaged 11 fatal truck crashes per year, while New Hampshire averaged 9 fatal truck crashes per year.

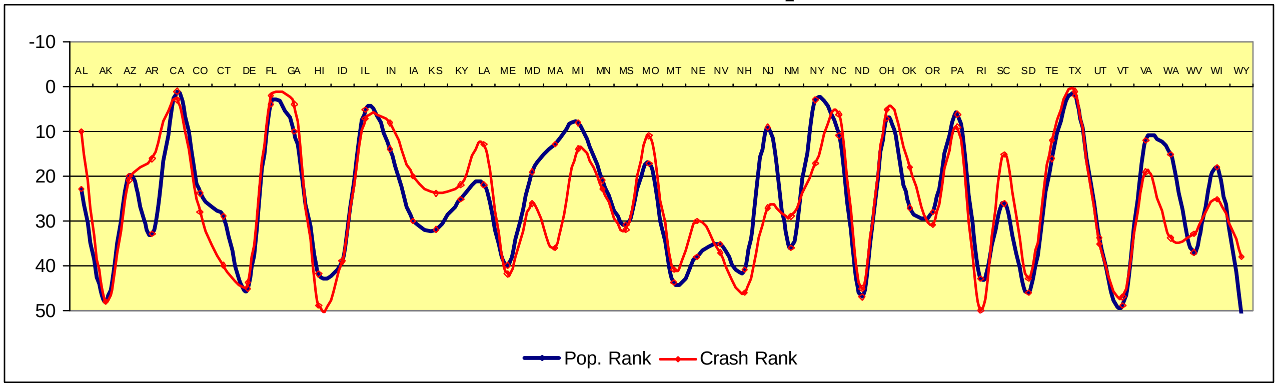
While population is far from a perfect predictor of commercial vehicle traffic, 7 of the 10 most populous states also averaged the most TST crashes (New York, Michigan and New Jersey were exceptions). The 10 least populous states also recorded the fewest fatal semi-truck crashes. Maine, 40th in state population, ranked 42 in fatal semi-truck crashes, and 43rd in truck ton-miles. New Hampshire, 41st in population ranked 43rd in fatal semi-truck crashes, and 45th in truck ton-miles.

Exhibit 26: Comparison of Fatal TST Crashes

State	Total Fatal Truck Crashes (1996-2000)	5-yr Annual Avg. Fatal Truck	Rank	2000 Census Population	Pop. Rank
AL	534	107	10	4,447,100	23
AK	12	2	48	626,932	48
AZ	305	61	21	5,130,632	20
AR	387	77	16	2,673,400	33
CA	873	175	3	33,871,648	1
CO	192	38	28	4,301,261	24
CT	72	14	40	3,405,565	29
DE	55	11	44	783,600	45
FL	884	177	2	15,982,378	4
GA	684	137	4	8,186,453	10
HI	7	1	49	1,211,537	42
ID	73	15	39	1,293,953	39
IL	602	120	7	12,419,293	5
IN	596	119	8	6,080,485	14
IA	306	61	20	2,926,324	30
KS	279	56	24	2,688,418	32
KY	286	57	22	4,041,769	25
LA	407	81	13	4,468,976	22
ME	56	11	42	1,274,923	40
MD	206	41	26	5,296,486	19
MA	109	22	36	6,349,097	13
MI	400	80	14	9,938,444	8
MN	282	56	23	4,919,479	21
MS	164	33	32	2,844,658	31
MO	511	102	11	5,595,211	17
MT	61	12	41	902,195	44
NE	183	37	30	1,711,263	38
NV	99	20	37	1,998,257	35
NH	43	9	46	1,235,786	41
NJ	197	39	27	8,414,350	9
NM	188	38	29	1,819,046	36
NY	350	70	17	18,976,457	3
NC	636	127	6	8,049,313	11
ND	44	9	45	642,200	47
OH	666	133	5	11,353,140	7
OK	348	70	18	3,450,654	27
OR	178	36	31	3,421,399	28
PA	537	107	9	12,281,054	6
RI	4	1	50	1,048,319	43
SC	389	78	15	4,012,012	26
SD	56	11	43	754,844	46
TE	508	102	12	5,689,283	16
TX	1462	292	1	20,851,820	2
UT	119	24	35	2,233,169	34
VT	27	5	47	608,827	49
VA	348	70	19	7,078,515	12
WA	142	28	34	5,894,121	15
WV	159	32	33	1,808,344	37
WI	271	54	25	5,363,675	18
WY	78	16	38	493,782	50

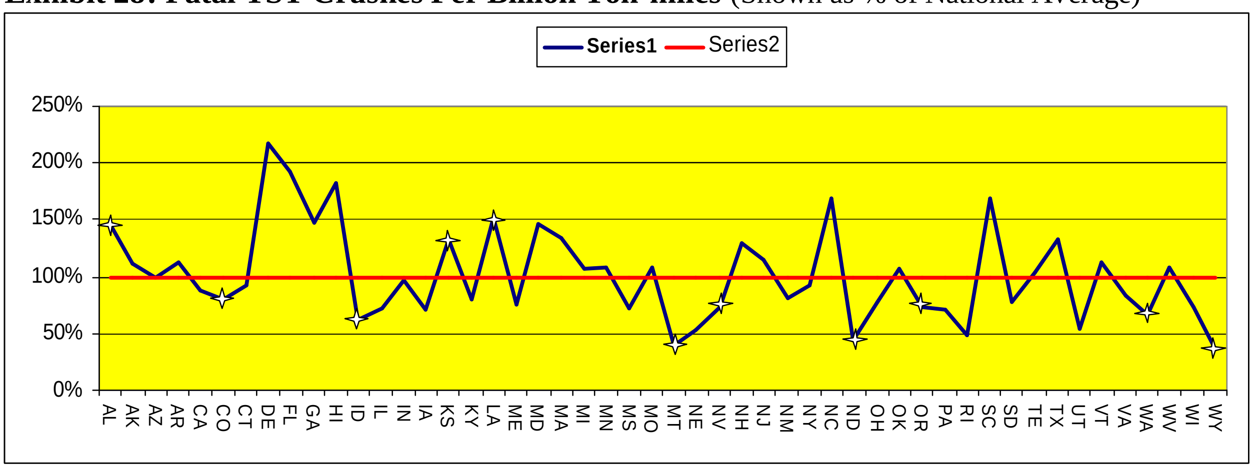
Exhibit 27 (next page) plots the rank of state population against the state rank for average annual fatal semi-truck crashes. The resulting histogram demonstrates that with a few exceptions, total population correlates closely with the average number of fatal TST crashes.

Exhibit 27: Annual Fatal Truck Crash Rank Vs. State Population Rank



The ability to relate crashes to traffic exposure is often a difficult goal at a sub-national level. The most common "crash rate" is crashes per 100 million VMT. However, other measures of exposure can be used, such as crashes per number of licensed drivers; or crashes per ton-mile. A "Fatal Semi-Truck Crash Rate" was computed using the TIFA 5 year average and state level ton-mile estimates from the 1997 BTS Commodity Flow Survey (CFS). **Exhibit 28** plots the result for each state against the national average (equal to 100%). The graph identifies those states falling above or below the average fatal crash rate for semi-trucks using ton-mile estimates as the denominator. Also highlighted on this graph are eleven states that allow GVW in excess of 80,000 lbs. in regular operations on state highway systems.†† Among the states allowing heavier trucks on state highways, only three have crash rates above the average. Three of these heavy truck states had TST crash rates less than 50% of the national average.

Exhibit 28: Fatal TST Crashes Per Billion Ton-miles (Shown as % of National Average)



Regression Analysis of Tractor-Semi-trailer (TST) Crashes

The study team also conducted a regression analysis to examine the correlations between TST crashes, cargo volume and truck VMT. An additional variable was introduced for the regression

†† Source: J.J. Keller – Vehicle Sizes and Weights, Maximum Limits table, January 1, 2003. (Note: several additional states, including Maine and New Hampshire only allow truck GVW's exceeding 80,000 lbs. under special circumstances; these states were not included on this list).

analysis: tractor-semi-trailer vehicle miles of travel (TST-VMT) by state. Highway Performance Monitoring System (HPMS) base data from FHWA containing VMT by functional class and vehicle type was used for the analysis. For each state, the 5 year average of fatal crashes involving TST combinations was regressed against year 2000 TST-VMT and year 1997 truck freight ton-miles. **Exhibit 29** presents the strongest relationships found from the regression analysis on these variables.

Exhibit 29: Regression on TST Annual Fatal Involvements (TST-FI)

(R-square = 0.906)	*Coefficients*	*Std Error*	*t Stat*	*P-value*
Intercept	35.2	7.64	4.603	0.000
a) TST-VMT (100 million)	32.8	2.51	13.079	0.000
b) ratio of truck ton-miles to all truck VMT	-43.6	8.53	-5.116	0.000
c) ratio of urban TST-VMT to all TST-VMT	-24.4	13.73	-1.778	0.082
d) normal GVW limit over 80,000 lbs	-7.4	6.64	-1.116	0.271

The most significant findings indicate:

- Row a) Results suggest a strong, positive relationship between TST-VMT and fatal TST crashes, indicating that fatal TST crashes are expected to <u>increase</u> as TST-VMT increases. This correlation holds across all states with greater than 99% confidence.
- Row b) Results show a strong <u>negative</u> relationship between the ratio of truck ton-miles to TST-VMT, and the number of fatal TST crashes, suggesting that fatal TST crashes are expected to <u>decrease</u> as average payload increases. The correlation holds across all states with greater than 99% confidence. This finding supports previous studies suggesting that higher payloads will likely reduce crashes, presumably by reducing TST-VMT.

Regression Results for Maine and New Hampshire

- Maine exhibited crash rates <u>below</u> the average by both VMT and ton-mile measures. A strong explanatory factor is Maine's ratio of ton-mile/truck VMT (6.039) is higher (106.61%) than the national average – in other words, Maine has higher than average truck payloads and based on the correlations found in the data, is expected to have a lower than average TST fatal crash rate.
- New Hampshire exhibited <u>above</u> average TST fatal crash rates under both VMT and ton-mile measures. A strong explanatory factor is New Hampshire's lower than average payloads.

Exhibit 30, on the next page shows the resulting state and national "semi-truck fatal crash rates" using both VMT and ton-miles as denominators.

Exhibit 30: Annual TST Fatal Involvements, Freight Ton-miles, and VMT

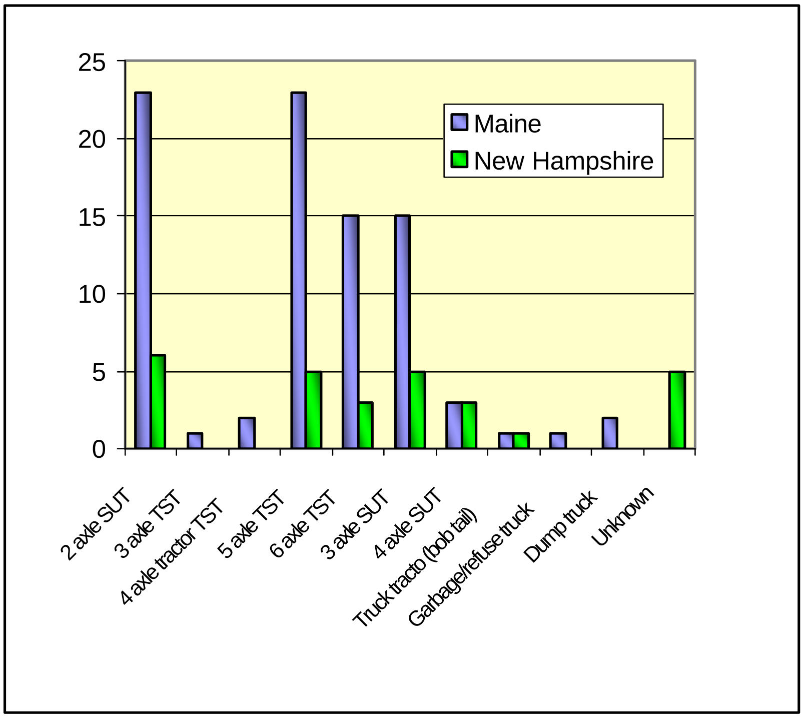
column **1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
State ★ = **d)** GVW over 80,000 lbs.	**TST Fatal Crashes** (5 yr. avg.)	Total Truck **ton-miles** (billions)	TST-Fatal Crash Rate per billion ton-miles	% of national average	**a)** TST-VMT (x100 mil)	TST-Fatal Crash Rate per 100 million VMT	% of national average	**b)** ratio of ton-miles / VMT for all trucks	% of national average	**c)** ratio of urban road / all road TST-VMT
Alabama	106.8	28.1	3.8	144%	3,143	3.4	146%	5.586	98.62%	34.0%
Alaska ★	2.4	0.8	2.9	111%	59	4.1	176%	3.756	66.31%	36.3%
Arizona	61	23.4	2.6	99%	3,356	1.8	78%	4.842	85.47%	36.8%
Arkansas	77.4	25.9	3.0	113%	2,332	3.3	143%	8.300	146.53%	13.6%
California	174.6	75.4	2.3	88%	9,733	1.8	77%	4.650	82.09%	61.6%
Colorado ★	38.4	18.2	2.1	80%	1,453	2.6	113%	6.458	114.02%	22.4%
Connecticut	14.4	6.0	2.4	91%	876	1.6	71%	4.382	77.35%	68.9%
Delaware	11	1.9	5.7	217%	280	3.9	168%	3.877	68.45%	50.7%
Florida	176.8	34.9	5.1	192%	5,069	3.5	150%	3.796	67.01%	50.0%
Georgia	136.8	35.1	3.9	148%	5,135	2.7	114%	4.549	80.31%	21.1%
Hawaii	1.4	0.3	4.8	183%	50	2.8	120%	0.948	16.73%	66.5%
Idaho ★	14.6	9.1	1.6	61%	665	2.2	94%	8.815	155.62%	20.1%
Illinois	120.4	63.7	1.9	72%	7,943	1.5	65%	6.182	109.14%	56.1%
Indiana	119.2	47.1	2.5	96%	5,882	2.0	87%	5.653	99.80%	38.0%
Iowa	61.2	32.7	1.9	71%	2,973	2.1	88%	8.330	147.05%	14.4%
Kansas ★	55.8	16.0	3.5	132%	1,390	4.0	172%	6.993	123.45%	13.7%
Kentucky	57.2	27.1	2.1	80%	2,357	2.4	104%	7.798	137.66%	22.9%
Louisiana	81.4	20.4	4.0	152%	2,558	3.2	137%	4.881	86.17%	33.1%
Maine	11.2	5.7	2.0	75%	532	2.1	90%	6.039	106.61%	13.7%
Maryland	41.2	10.6	3.9	147%	949	4.3	186%	4.433	78.26%	63.0%
Massachusetts	21.8	6.2	3.5	134%	1,082	2.0	87%	2.945	52.00%	77.8%
Michigan ★	80	28.5	2.8	107%	3,699	2.2	93%	4.890	86.32%	55.0%
Minnesota	56.4	19.6	2.9	109%	1,751	3.2	138%	5.732	101.20%	23.9%
Mississippi	32.8	17.1	1.9	73%	2,594	1.3	54%	4.380	77.33%	19.2%
Missouri	102.2	35.8	2.9	108%	3,683	2.8	119%	6.430	113.51%	25.3%
Montana ★	12.2	11.9	1.0	39%	539	2.3	97%	14.492	255.84%	10.9%
Nebraska	36.6	26.1	1.4	53%	1,737	2.1	90%	12.361	218.21%	10.1%
Nevada ★	19.8	10.2	1.9	73%	780	2.5	109%	7.954	140.41%	25.4%
New Hampshire	8.6	2.5	3.4	129%	252	3.4	146%	4.650	82.10%	27.9%
New Jersey	39.4	13.0	3.0	115%	2,188	1.8	77%	3.604	63.62%	79.0%
New Mexico	37.6	17.4	2.2	82%	1,429	2.6	113%	7.790	137.53%	11.8%
New York	70	28.9	2.4	92%	4,503	1.6	67%	3.925	69.28%	48.3%
North Carolina	127.2	28.7	4.4	168%	4,850	2.6	113%	3.449	60.88%	34.5%
North Dakota ★	8.8	7.7	1.1	43%	459	1.9	82%	10.091	178.15%	10.0%
Ohio	133.2	64.5	2.1	78%	8,194	1.6	70%	5.703	100.68%	44.4%
Oklahoma	69.6	24.5	2.8	108%	3,412	2.0	88%	4.965	87.65%	17.9%
Oregon ★	35.6	18.1	2.0	75%	2,185	1.6	70%	5.691	100.46%	24.4%
Pennsylvania	107.4	56.9	1.9	72%	4,692	2.3	98%	7.312	129.09%	34.5%
Rhode Island	0.8	0.6	1.3	48%	153	0.5	23%	2.371	41.85%	76.4%
South Carolina	77.8	17.4	4.5	169%	2,190	3.6	153%	5.147	90.86%	20.1%
South Dakota	11.2	5.4	2.1	78%	519	2.2	93%	6.885	121.55%	10.5%
Tennessee	101.6	37.2	2.7	104%	3,898	2.6	112%	6.814	120.29%	33.3%
Texas	292.4	83.5	3.5	133%	10,065	2.9	125%	5.148	90.89%	37.8%
Utah	23.8	16.8	1.4	54%	930	2.6	110%	11.172	197.23%	34.5%
Vermont	5.4	1.8	3.0	114%	260	2.1	89%	4.099	72.36%	20.9%
Virginia	69.6	31.7	2.2	83%	3,286	2.1	91%	6.585	116.25%	29.1%
Washington ★	28.4	16.1	1.8	67%	1,306	2.2	93%	5.802	102.43%	50.7%
West Virginia	31.8	11.1	2.9	108%	1,271	2.5	107%	6.179	109.09%	25.6%
Wisconsin	54.2	27.9	1.9	74%	2,479	2.2	94%	7.022	123.97%	29.2%
Wyoming ★	15.6	16.1	1.0	37%	901	1.7	74%	14.384	253.93%	6.4%
all U.S.	3,076.0	1,165.3	**2.6**		132,021	2.3		**5.664**		**37.2%**

Fatal Truck Crash Trends in Maine and New Hampshire

The first portion of the safety analysis provided a detailed examination of geo-coded crash data, normalized by TST-VMT estimates for Maine. As similar data was not available in New Hampshire, the study team also examined non-normalized crash data in detail for both states.

The States of Maine and New Hampshire also provided three years worth of fatal truck crash data (1999-2001). Fatal crash records for Maine indicate 78 fatal truck crashes in Maine over the period. Most of these crashes (74) were multiple vehicle incidents, with 16 crashes involving more than two vehicles. **Exhibit 31** displays fatal truck crashes for both Maine and New Hampshire by vehicle type; years 1999 – 2001. The data indicates that single unit trucks (SUT) and TST combinations were equally involved in fatal crashes in both states. In New Hampshire, 32 of 33 fatal truck crashes during the time frame examined were multiple vehicle crashes. ‡

Exhibit 31: Fatal Crashes by Vehicle Type: ME & NH

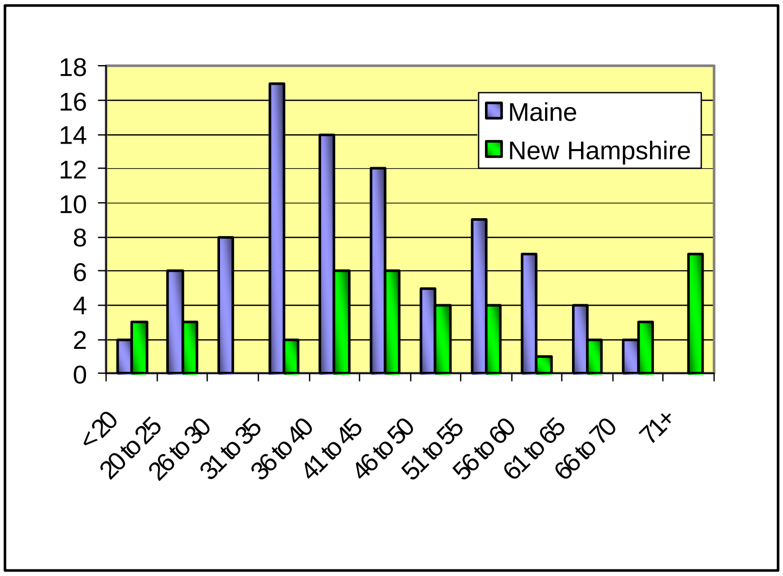


A review was made of fatal crash records to determine those crashes were the truck driver was found to be at fault. In "truck driver-at-fault crashes, the most prominent contributing factor in Maine was driver inattention or distraction (6 fatal crashes), followed by illegal or unsafe speed (2 fatal crashes). New Hampshire records indicated only two crashes where the commercial vehicle driver was determined to be "at fault." In one crash the commercial vehicle driver was under the influence (In four crashes the driver of the other vehicle was under the influence). Fatigue was a contributing factor for the other (non-truck) driver in three fatal crashes. Fatigue attributed to the commercial vehicle driver was not listed as a factor in any of the New Hampshire records.

‡ Minor differences sometimes existed in state and federal data regarding the total numbers of fatal trucks crashes over the period. Crash records received from Maine indicated 78 fatal truck involved crashes from 1999-2001, FARS data indicated 76. The data supplied by the State of New Hampshire indicate 28 fatal crashes during the period, the FARS data indicated 33.

Exhibit 32 presents fatal truck crashes in Maine and New Hampshire related to the truck driver's age.

Exhibit 32: Fatal Truck Crashes by Driver Age (1999-2001)



For Maine:

- Truck drivers between the ages of 31 and 35 were the driver group most likely to be involved in a fatal crash.
- Drivers age 36 to 40 were the next most represented group, followed by drivers age 41 to 45.
- These three driver age groups, representing drivers age 31 to 45, were involved in 50% of all fatal crashes during the period.

For New Hampshire:

- Truck drivers 71 years or older represented the age group most involved in fatal truck crashes.
- Drivers 36 to 40, and 41 to 45 were next two groups most represented in fatal crashes.
- Drivers in these three age groups accounted for more than half (58%) of all fatal truck crashes in New Hampshire.

Exhibit 33 presents a histogram of crashes by the type of crash resulting in a fatality. The most prominent fatal crash type involving commercial vehicles in both states was head-on/sideswipe. In Maine rear end/sideswipe and intersection movement collisions were also prominent. Of the most prominent crash type (head-on/side-swipe) only one crash in Maine was attributed to the commercial vehicle driver.

Exhibit 33: Fatal Truck Crashes by Type (1999-2001)

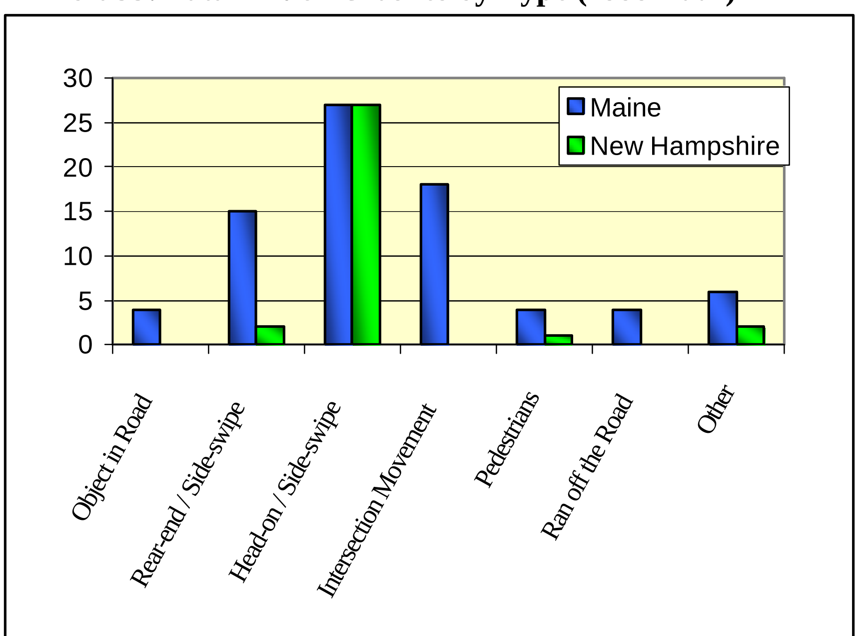


Exhibit 34: Fatal Truck Crashes by Time of Day (1999-2001)

Exhibit 34 summarizes the fatal truck crashes by the time of day in which they occurred. More than 80% of the fatal crashes occurred during the daytime hours of 6:00 am to 6:00 pm., of these crashes, most occurred on unlit roadways. The weekday distribution of fatal crashes was fairly even, with only a few crashes occuring on weekends.

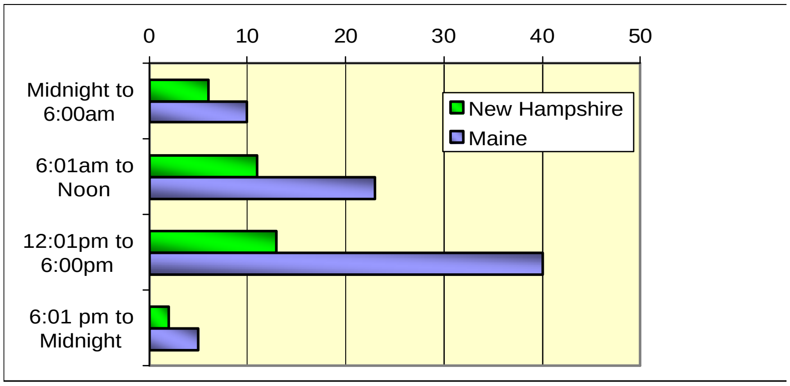


Exhibit 35: Fatal Truck by Weather Condition (1999-2001)

Exhibit 35 presents information about weather conditions at the time of each fatal crash occurance. Nearly three-quarters (73%) of the crashes in Maine, and all but two in New Hampshire, occurred during clear weather conditions. An examination of the road surface conditions also found that over 80% of these crashes occurred on dry pavement.

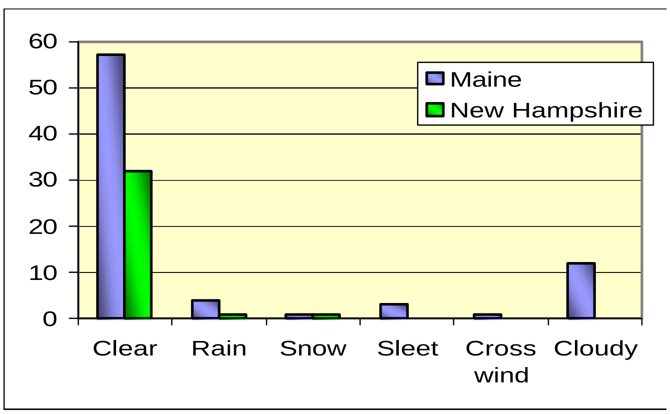
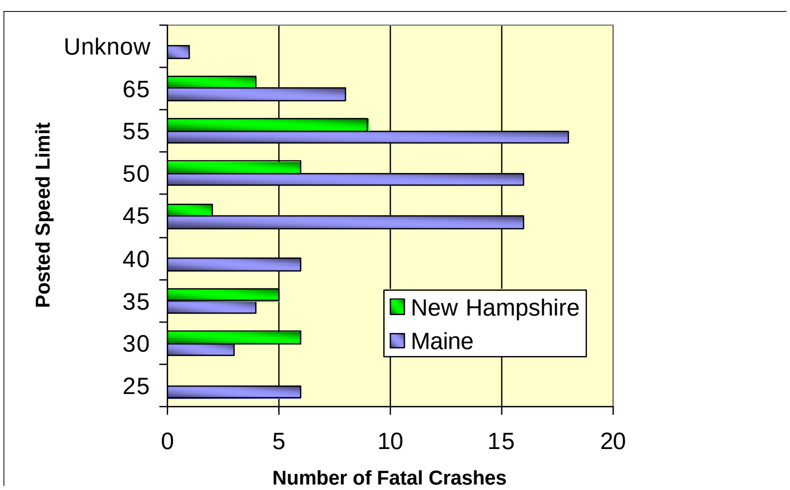


Exhibit 36: Fatal Truck by Posted Speed Limit (1999-2001)

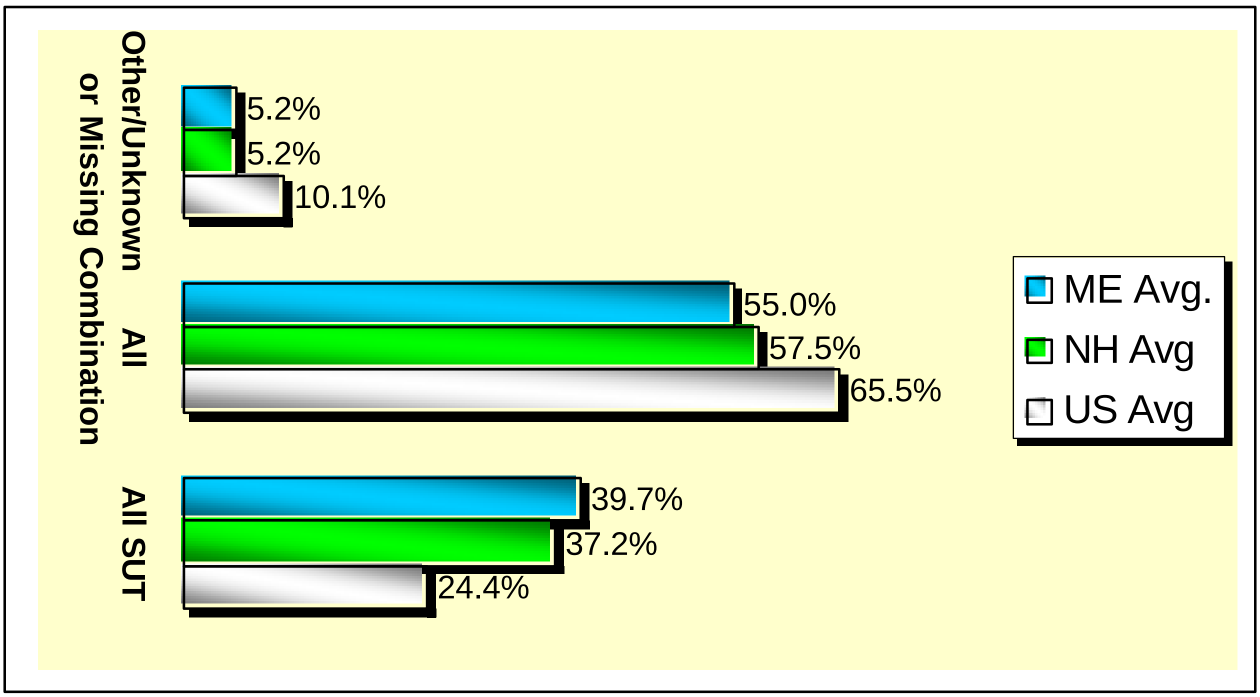
Exhibit 36 provides information on the posted speed limit at the location of the crash occurrence. As the majority of the fatal truck crashes in Maine and New Hampshire occurred on non-Interstate facilities, the majority of the posted speed limits were 55 miles per hour (mph) or less.



Non-fatal truck crashes in Maine and New Hampshire were also compared to national statistics using the Motor Carrier Management Information System (MCMIS) database, available online from the Federal Motor Carrier Safety Administration (FMCSA). The MCMIS database contains information nationally about non-fatal truck crashes. Fatal crashes are captured in the FARS. Users of the MCMIS are cautioned that the database currently captures only about 60% of all state-reportable truck crashes for the nation, and that reporting accuracy varies by state. For the three year period Maine reported 1,571 non-fatal truck crashes and New Hampshire reported 390 non-fatal truck crashes.

Exhibit 37 presents three years of crash data from MCMIS data (1999 – 2001) about the type of commercial vehicles involved in non-fatal crashes. The table shows crashes by specific vehicle types as a percent of total crashes. The bar chart groups the specific vehicle classes into three categories: 1) All single unit trucks, 2) All combination trucks, and 3) Other or unknown.[§§]

Exhibit 37: Truck Crash Profile (non-fatal) for Maine & New Hampshire by Vehicle Type



[§§] Note: Two categories "Tractor/triples" and "Missing" were dropped from the totals because they did not appear, or represented less than 1% of the Maine and New Hampshire data. Truck-tractor (bobtail) percentages were included in the "Other" category).

Smmary Conclusions Regarding Safety and Weight Policy

The analysis undertaken for this study has: 1) Provided a detailed examination for three years of geo-coded crash records looking specifically at 5 and 6-axle TST vehicles in Maine; 2) Examined national trends for fatal crashes involving large trucks, 3) Conducted a comparative analysis of truck crash statistics for Maine and New Hampshire as compared to other states and national averages, and; 4) Constructed fatal and non-fatal truck crash profiles for three years of crash data for Maine and New Hampshire. The most prominent findings from this investigation are:

- ✓ Nationally, the safety of large trucks (and combination trucks in particular) has shown dramatic improvements in safety as measured by fatal crash rates.

- ✓ The crash rate experience of 5 and 6 axle TST combination vehicles registered to carry commodities at the weights under study are 7 to 10 times higher on non-Interstate facilities in Maine, than on the Maine Turnpike. These findings are consistent with national studies that have found a strong relationship between road class and crash risk, with fatal crash rates on rural Interstate highway facilities 300 to 400 percent less that other types of rural roadways (i.e. trucks traveling on rural interstates are 3 to 4 times less likely to have a fatal crash than trucks traveling on rural state and county highways).

- ✓ If the current weight exemption on the Maine and New Hampshire Turnpike were discontinued, these states combined would experience six additional crashes each year having an economic impact of more than $540,000.

- ✓ The state comparison analysis also found no correlation between states that allow GVW in excess of 80,000 lbs. in normal operations on state networks and high crash rates; in fact, the regression analysis found a positive correlation between low crash rates and high load factors. And, in comparison to other states the crash rate for TST vehicles in Maine was slightly below the national average. Overall, the comparison of population and fatal TST crashes showed both Maine and New Hampshire to rank where expected in comparison to other states.

Pavement Analysis

State highway agencies design highway infrastructure based on predicted truck traffic volumes and axle weights. The majority of pavement wear (also referred to as pavement consumption) is attributed to heavy truck traffic. Currently the States of Maine and New Hampshire together spend nearly $75 million each year on pavement rehabilitation and preservation. From an operations and maintenance standpoint, vehicle axle loads and environment are the primarily determinants of pavement wear. Other factors affecting the wear-ability of pavements fall primarily to construction standards such as the type of sub-base, paving material and pavement thickness. Changes to TS&W policy can substantially impact the costs for pavement maintenance and rehabilitation. The objective of the pavement analysis conducted for this study is to relate the impact from changes in axle loadings under the policy scenarios to reflect pavement damage in terms of potential state expenditures. The approach taken in this study uses pavement consumption factors referred to as Equivalent Single Axle Loads (ESAL) to estimate changes in pavement wear.

Pavement Fatigue

"The break-up of pavements is usually caused by fatigue. Fatigue or fatigue cracking is caused by many repeated loadings and the heavier the loads the fewer the number of repetitions required to reach the same condition of cracking. It is possible, especially for a thin pavement, for one very heavy load to break up the pavement in the two wheel paths. To account for the effect of different axle weights, the relative amount of fatigue for an axle at a given weight is compared to that of a standard weight axle. Historically this standard axle has been a single-axle with dual tires and an 18,000-lb. load."

- Comprehensive Truck Size and Weight Study (USDOT, Dec. 2000)

ESAL factors provide a means of readily assessing the relative damage resulting from loaded commercial vehicles on pavements. ESAL values are calculated to standardize the measurement pavement wear from a wide variety of trucks, carrying a wide range of loads. One ESAL is generally defined as one four-tired axle bearing an 18,000 lb. load.

Using an ESAL approach the damage or "consumption" of pavement from different vehicle loads are normalized by relating the damage to a standard reference axle weight (18,000 lb. single axle load). Road tests have established that the relationship between axle weight and pavement damage is a logarithmic function. For example, a 36,000 lb. single-axle load does approximately 20 times more damage than an 18,000 lb. single-axle load. So, even though the load is only twice the magnitude, the calculated ESAL factor is 21.2.[6] (The example is based on a structural pavement number of 3 and a terminal serviceability level of 2.0). Thus, axle weight and pavement consumption exhibit a logarithmic relationship, making the analysis of many vehicles and pavement types difficult. Converting axle loads to ESALs prior to analysis allows the analysis of a straightforward, linear relationship wherein two ESALs consume twice the pavement as a single ESAL, and three ESALs consume three times as much, and so on.

Pavement Cost Impacts Methodology

A methodology was developed to quantify the impact on pavement performance and cost characteristics of the incremental load effects resulting from a comparison of the current exempt policy on the ME/NH Turnpike to a no-exemption scenario. The magnitude and pattern of truck traffic expected from implementation of the study policy scenario was calculated using a four step process:

- Assigning *base* (existing) truck traffic (vehicle classes 4-13) and ESAL loadings to the study network (derived from WIM stations);
- Assigning truck traffic expected to divert to non-Interstate *diversion* highways if the current Turnpike exemption were ended;
- Calculate the *increment* in 5- and 6-axle volumes and associated ESAL loadings (positive or negative) between the current condition and study scenario; and
- Calculate the cost impacts relating to the incremental ESAL loadings between the base and study scenarios.

The equation used in deriving ESAL factors for the analysis was that used at Maine's WIM stations, and is taken from the *1986 AASHTO Guide for Design of Pavement Structures*. MDOT's pavement management criteria uses a *structural pavement number* (SN) of 5 and a pavement "*terminal serviceability level*" (P_t) of 2.5. These criteria were used throughout the analysis. The follow equation was used in deriving ESAL factors from the WIM stations traffic data:

$$bc = 0.04 + \frac{0.081 \times (L_x + L_2)^{3.23}}{(SN+1)^{5.19} \times L_2^{\ 3.23}}$$

Where L_x is the load on the whole axle group; L_2 is the axle group code (1 for single, 2 for tandem, 3 for tridem).

The pattern and magnitude of incremental traffic was identified through the distribution of commodity tonnage data purchased for the study, and supplemented with WIM data provided by Maine and New Hampshire. The WIM station ESAL factors included the full range of 5 and 6-axle TST weights, including trucks above exempt weights recorded at the WIM stations.

Step 1: Base Scenario Vehicle / ESAL Traffic Distribution

The Base Scenario was developed to reflect current truck traffic patterns by assigning the 5- and 6-axle commodity tonnage data to the analysis network. In the base scenario, all analysis network links representing Turnpike facilities were *enabled* so that the commodity tonnage data would be assigned to those links. All non-Turnpike Interstate facilities were "turned-off" and prohibited from being assigned any commodity tonnage volumes.

The conversion process described in **Appendix C** was then used to convert assigned tons to numbers of 5- and 6-axle trucks. Then, the ESAL factors described found in **Table C-1** of the appendix were used to convert truck volumes to ESALs.

Step 2: Study Scenario Vehicle / ESAL Traffic Distribution

To develop the study scenario, the links previously *enabled* in the base scenario (Turnpike facilities) were *disabled*. This yielded an analysis network representative of the study condition – one where all Interstate facilities in Maine and New Hampshire, including the Turnpikes are prohibited from carrying 5- and 6-axle vehicles weighing over 80,000 lbs. Next 5- and 6-axle commodity tonnages were assigned to diversion routes of the study network. Again, the conversion process described in **Appendix C** was used to convert assigned tons to numbers of 5- and 6-axle trucks.

Step 3: Comparison of Base and Study Scenarios

The diversion network developed for this study is composed of roadway facilities both having heavy truck traffic drawn *from* them, as well as those having heavy truck traffic drawn *to* them. A complete analysis of pavement impacts must account for both instances. In total, the ME/NH Turnpike analysis examined over 13,000 road segments. Comparisons of base scenario ESAL loadings on the diversion network were separated into those facilities that *lose* heavy truck traffic given implementation of the study scenario, and those that *gain* heavy truck traffic.

Step 4: Estimating Maintenance & Rehabilitation Budget Savings

It was assumed in this analysis that a the percentage reduction (or gain) in ESAL loadings equated to an equal percentage in resurfacing cost savings (or increases) for roadway type, based on existing MDOT and NHDOT expenditures. To assign these costs it was necessary to develop a measure describing the amount spent for each unit of pavement consumption by highway type (using the federal functional highway classification system).

The tables in **Exhibits 38** and **39** summarize the incremental differences in truck volumes and associated ESAL loadings on the study network that were observed by model runs of both the base and study scenarios for Maine and New Hampshire, respectively. As expected, if the weight exemption currently in force were rescinded, 5 and 6 axle TST traffic on non-interstate highways types would increase, while traffic on Interstate routes (Turnpikes) would decrease.

Exhibit 38: Summary Impacts to Maine Pavements for the Study Scenario*

Functional Highway Class	Change in Daily Truck-Miles - Five Axle	Change in Daily Truck-Miles - Six Axle	Total Change in Daily Truck-Miles	Change in Daily ESAL-Miles - Five Axle	Change in Daily ESAL-Miles - Six Axle	Total Change in Daily ESAL-Miles
Major/Urban Collector	747	1,382	2,129	2,891	5,775	8,666
Minor Arterial	3,163	7,034	10,196	12,241	29,403	41,644
Principal Arterial - Other	2,398	6,456	8,854	9,284	26,990	36,273
Principal Arterial - Interstate	-5,258	-15,578	-20,836	-20,349	-65,115	-85,465

Exhibit 39: Summary of Impacts to New Hampshire Pavements for the Study Scenario*

Functional Highway Class	Change in Daily Truck-Miles - Five Axle	Change in Daily Truck-Miles - Six Axle	Total Change in Daily Truck-Miles	Change in Daily ESAL-Miles - Five Axle	Change in Daily ESAL-Miles - Six Axle	Total Change in Daily ESAL-Miles
Major/Urban Collector	6	4	10	23	18	41
Minor Arterial	537	65	603	2,077	273	2,350
Principal Arterial - Other	2,238	1,578	3,816	8,663	6,597	15,260
Principal Arterial - Interstate	-730	-1,148	-1,877	-2,824	-4,797	-7,621

Calculation of Base Pavement Use: Maine

A prorating methodology was used to assign base scenario truck volume and ESAL estimates (vehicle classes 4-13) to the MDOT TIDE route system. Unlike in the development of the base and study scenarios, volume and ESAL calculations and assignments were made using MDOT's vehicle volume counts and ESAL factors, not those derived from commodity tonnage data.

Maine provided updated 2003 ESAL factors from its WIM stations allowing ESAL factors by vehicle classification for each WIM station were assigned to links on the MDOT TIDE route system based on the proximity of route links to a given WIM station. Using the previously-described distance-weighted prorate procedure, classified volumes and associated ESAL values were assigned to the Maine portion of the study network. Next, values for vehicle-miles and ESAL-miles were summarized for each functional system and divided into the state's pavement resurfacing program budget by functional highway type.

* For purposes of this analysis, the functional system "Principal Arterial – Other Freeways & Expressways" has been grouped with "Other Principal Arterial."

Calculation of Base Pavement Use: New Hampshire

New Hampshire's coverage of vehicle classification count stations is not as extensive as Maine's, so base pavement consumption data for New Hampshire was derived from that identified for the Maine network. For each roadway and vehicle class an "average ESAL/AADT" value was calculated and applied to AADT values for the New Hampshire network.

Development of Base Unit Costs: MDOT and NHDOT provided historical cost details about their pavement resurfacing programs, representative of the *entire* mileage for each functional system. System-wide programmed pavement maintenance was used to develop a *cost per ESAL-mile* normalized for each functional system element, which were then applied to the study network. It was assumed that historically pavement budgets would be programmed to system elements based on their need and that historical maintenance need would be linked to the number axle loads (expressed as ESALs) traveling over those systems. The cost per ESAL-mile factor was applied to incremental ESAL loadings (positive or negative) to determine cost impacts for the study scenario. The pavement resurfacing cost calculations for both Maine and New Hampshire are summarized in the tables of **Exhibits 40 and 41**

Exhibit 40: MDOT Resurfacing Cost per ESAL-Mile by Functional System

Functional Highway Class	Known ESAL-Mi. Vehicle Class 4-13	Assoc Length: Known ESAL-Mi.	Total System Length (Mi)	Expanded ESAL-Miles	98-'05 MDOT Program (Low)	98-'05 MDOT Program (High)	Cost / ESAL-Mi. (Low)	Cost / ESAL-Mi. (High)
Major/Urban Collector	518,827	1,568	3,739.3	1,237,316	$14,545,380	$31,649,670	$11.76	$25.58
Minor Arterial	592,553	1,117	1,327.8	704,550	$16,832,350	$33,707,880	$23.89	$47.84
Principal Arterial - Other	870,496	892	981.3	958,148	$18,478,700	$25,929,400	$19.29	$27.06
Principal Arterial - Interstate	1,318,870	302	366.8	1,601,753	$9,558,000	$15,344,000	$5.97	$9.58

Exhibit 41: NHDOT Resurfacing Cost per ESAL-Mile by Functional System

Functional Highway Class	Known ESAL-Mi. Vehicle Class 4-13	Assoc Length: Known ESAL-Mi.	Total System Length (Mi)	Expanded ESAL-Miles	98-'05 MDOT Program (Low)	98-'05 MDOT Program (High)	Cost / ESAL-Mi. (Low)	Cost / ESAL-Mi. (High)
Major/Urban Collector	6	4	10	23	18	41	$0.27	$0.33
Minor Arterial	537	65	603	2,077	273	2,350	$7.50	$9.17
Principal Arterial – Other	2,238	1,578	3,816	8,663	6,597	15,260	$4.77	$5.83
Principal Arterial – Interstate	-730	-1,148	-1,877	-2,824	-4,797	-7,621	$6.38	$8.05

Exhibits 42 and 43 below show the remaining steps and results from the methodology used to calculate changes in annual pavement costs. Using the historical high and low allocation provides an expected range of cost impacts. These values are representative of the cost (or savings) that would be realized through the addition (or removal) of one ESAL-mile to a given functional system. The following pavement resurfacing costs are anticipated from implementing the study scenario.

Exhibit 42: Cost Impacts to MDOT Resurfacing Program if Exemption Rescinded

Functional Highway Class	Total Change in Daily ESAL-Miles	'98-'05 Resurfacing Expenditure/Daily ESAL-Mile (Low)	'98-'05 Resurfacing Expenditure/Daily ESAL-Mile (High)	Change in MDOT Resurfacing Program (Low)	Change in MDOT Resurfacing Program (High)
Major/Urban Collector	8,666	$11.76	$25.58	$101,865	$221,650
Minor Arterial	41,644	$23.89	$47.84	$994,791	$1,992,134
Oth. Principal Arterial	36,273	$19.29	$27.06	$699,701	$981,824
Turnpike	-85,465	$5.97	$9.58	($510,065)	($818,836)
			Total Cost	$1,286,292	$2,376,772

Exhibit 43: Cost Impacts to NHDOT Resurfacing Program if Exemption Rescinded

Functional Highway Class	Total Change in Daily ESAL-Miles	2003 Resurfacing Expenditure/Daily ESAL-Mile (Low)	2003 Resurfacing Expenditure/Daily ESAL-Mile (High)	Change in NHDOT Resurfacing Program (Low)	Change in NHDOT Resurfacing Program (High)
Major/Urban Collector	41	$0.27	$0.33	$11	$14
Minor Arterial	2,350	$7.50	$9.17	$17,633	$21,551
Oth. Principal Arterial	15,260	$4.77	$5.83	$72,819	$89,001
Turnpike	-7,621	$6.38	$8.05	($48,616)	($61,372)
			Total Cost	$41,847	$49,194

The pavement analysis indicates that if the current Turnpike Exemption were to end, the State of Maine would experience higher pavement rehabilitation costs each year of between $1.29 million and $2.38 million. For the State of New Hampshire pavement rehabilitation costs would increase between $41,847 and $49,194.

Bridge Analysis

Bridges represent critical links and potential bottlenecks in highway transport systems for freight. The impacts of truck size and weight on bridge stress and fatigue remains one of the more controversial issues associated with truck regulatory policy, due to the complexity in analyzing a wide variety of structures and the high costs associated with bridge replacement. The current federal bridge formula (FBF) also represents the limiting factor in current gross weight policy on the Federal Interstate Highway System.

Exhibit 44: Bridges by Functional Highway Class

	Functional Highway Class	Maine	New Hampshire
Rural	Principal Arterial - Interstate	177	260
Rural	Principal Arterial - Other	133	189
Rural	Minor Arterial	186	133
Rural	Major Collector	458	256
Rural	Minor Collector	268	201
Rural	Local	746	927
Urban	Principal Arterial - Interstate	96	104
Urban	Principal Arterial - Other freeway/expressway	21	43
Urban	Principal Arterial - Other	70	82
Urban	Minor Arterial	77	103
Urban	Collector	81	52
Urban	Local	50	80
	Totals	**2,363**	**2,430**

The National Bridge Inventory System (NBIS) lists 2,363 bridges in the State of Maine, and 2,430 in the State of New Hampshire. The table in **Exhibit 44** provides an inventory of bridges by functional highway class in the States of Maine and New Hampshire. Of the more than five thousand bridges in the two states, just over 13% are located on the Interstate Highway System.

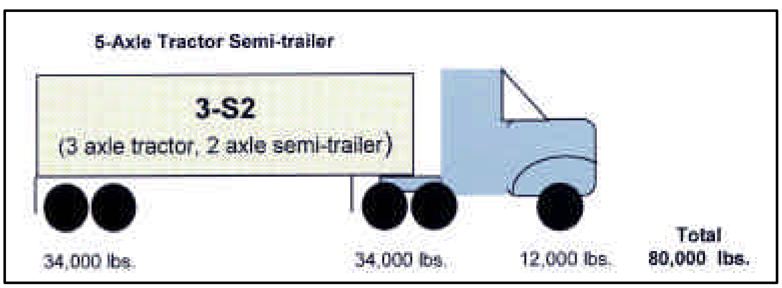
Bridge Impacts Analysis Methodology

The Three Loading Cases that were considered are as follows:

Case 1: 80,000 lb. Truck, Base Loading Case: corresponds to a "3-S2" (**Exhibit 45)** with the following axle load distribution:

- Steering Axle = 12,000 Lb.
- Forward Tandem Axle = 34,000 Lb.
- Rear Tandem Axle = 34,000 Lb.

Exhibit 45: Five-Axle TST Base Vehicle



(Note: Maximum tandem axle load under Maine General Law, assumed to be spaced at 14 ft from the front steering axle to the centerline of the tandem axle. For simple spans, use shortest allowable total wheelbase of 51' as per the Federal Bridge Formula (FBF).

Case 2: 88,000 Lb. Truck, 5-Axle Loading Case: Also for a 3-S2 vehicle (**Exhibit 46)** with the following axle loading distribution:

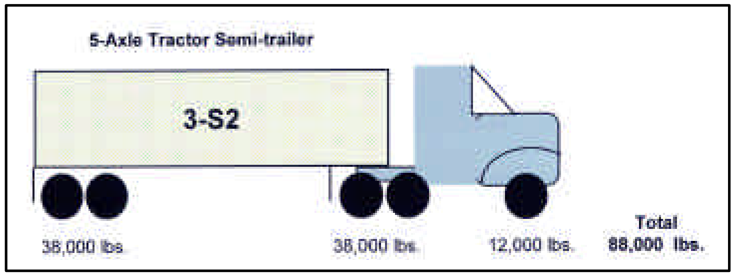
Exhibit 46: Five-axle TST Study Vehicle

- Steering Axle = 12,000 Lb.
- Forward Tandem = 38,000 Lb.

(Assumed to be spaced at 14 ft from the front Steering Axle to the centerline of the Tandem Axle)

- Rear Tandem = 38,000 Lb.

(With a total wheel base of 59')



Case 3: 100,000 Lb. Truck, 6 Axle Loading Case: Corresponds to a 3-S3 vehicle (**Exhibit 47)** with the following axle loading distribution:

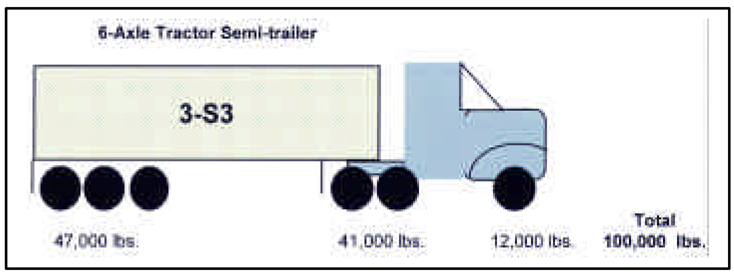
Exhibit 47: 6-Axle TST Study Vehicle

- Steering Axle = 12,000 Lb.
- Forward Tandem = 41,000 Lb.

(Assumed to be spaced at 12 ft from the Steering Axle)

- Rear Tri-axle = 47,000 Lb.

(Spacing of 32 ft center of tandem axle to center of the tri-axle, with a total wheel base of 50')



Note: Cases 2 and 3 trucks do not meet the federal bridge formula. While other axle configurations and axle weight distributions maybe legally allowed in Maine and New Hampshire and that Cases 2 and 3 are assumed to be the most representative of the trucks currently operating on the Maine and New Hampshire Turnpikes.

The cost impacts upon Maine and New Hampshire bridges due to the GVW policy change under consideration were analyzed from two different perspectives:

1. The increase or decrease in normal wear and tear and associated maintenance.
2. The long term effect of the loading with regards to fatigue of the bridge superstructure.

Two groups of bridges were analyzed in conducting the analysis:

Group 1) Bridges on the Maine and New Hampshire Turnpike.

Group 2) Those bridges located on State Routes which would be impacted due to changes in the traffic stream pursuant to the Non-Exempt scenario.

For each group of bridges, the study developed truck volumes by vehicle type, which apply for the three loading cases:

The Non-Exempt Scenario for:	a)	80,000 lb. truck conforming to federal weight limits
The "Exempt" Status for:	a)	The 88,000 lb. 5 axle truck, and
	b)	The 100,000 lb. 6 axle truck

Available bridge inventory data was obtained and reviewed for the bridges being considered. Maine and New Hampshire DOTs and Turnpike Authorities provided Structural Inventory and Appraisal (SI&A) data for each bridge, containing most of the inventory information needed, including: year built, structure type, condition ratings, number of lanes and spans, Inventory and Operating Load Ratings, traffic data (AADT, per cent of trucks and the year AADT was taken), etc. The list of bridges analyzed for the analysis can be found in **Appendix D.** The bridges to be considered were defined by construction material, structural type and relative span length. The maintenance cost analysis, was conducted for all structures with bridge decks. Structures under fill were excluded as they do not have a deck that comes in contact with the wheels.

The longer term effects of exempt weight vehicles were studied by investigating the change in bridge fatigue life. Concrete bridges were not include in the long term impacts analysis, as they are relatively unaffected by fatigue. Steel bridges were grouped by span length, overall length and span configuration. Cost estimates were developed (in 2003 Dollars) for two cost categories:

1) Periodic Maintenance - Costs based on historic records and published references.

2) Major Rehabilitation - Based on accepted average costs.

Because the fatigue analysis indicated that the normal life cycle of the structures would not be significantly affected, replacement costs were not estimated.

Periodic Maintenance Costs: The structure elements most affected by increasing or decreasing loadings on a bridge, are the bridge deck, deck joints, and scuppers. The axel loads of the study vehicles are not significantly heavier than the standard HS-20 design truck widely used for Interstate bridge standards. However, the somewhat larger load would result in accelerated deterioration of the deck elements.

Maintenance and rehabilitation costs are based on the length and width of the bridges. This information was supplied by the Maine and New Hampshire DOTs and supplemented when necessary from the National Bridge Inventory System (NBIS). *(Assumptions used in calculating maintenance costs can be found in Tech Memo 3B).* Cost impacts (increase or decrease) were calculated for each bridge depending on how traffic on the bridge would be affected by the policy change under study. The maintenance costs shown in the tables found in **Exhibits 48A and 48B** test the study scenario (non-exempt), and represent the costs or savings that would be incurred if current weight exemption on the Maine and New Hampshire Turnpikes were discontinued. On bridges that no longer carry as much exempt weight traffic, maintenance costs decrease. Conversely, on structures with more exempt weight vehicles the maintenance costs will increase.

Exhibit 48A: New Hampshire Bridge Maintenance Cost Impacts

PRIMARY ROUTE	TOWN NAME	BRIDGE NO.	Truck Volume Change	Maintenance Cost Category: Deck Repair	Deck Joint	Scupper
S16	TAMWORTH	037/166	6	$1,851	$673	$83
U2	SHELBURNE	049/089	6	$3,042	$869	$83
	EPPING	051/053	166	$11,577	$2,058	$250
S16	PINKHAMS GRANT	058/048	6	$2,739	$996	$83
S16	ROCHESTER	059/096	-1	$0	$0	$0
S101	AUBURN	060/133	19	$6,549	$873	$83
S101	AUBURN	060/134	17	$6,534	$871	$83
S16	PINKHAMS GRANT	065/073	6	$10,190	$867	$83
U3	ALLENSTOWN	071/047	4	$0	$0	$0
	HENNIKER	072/103	33	$0	$0	$0
S125	LEE	073/084	166	$0	$0	$0
U3	ASHLAND	076/080	0	$0	$0	$0
S16	GORHAM	077/038	6	$4,084	$990	$83
U2	SHELBURNE	077/105	6	$1,835	$863	$83
U302	CONWAY	079/063	6	$3,025	$931	$83
U2	SHELBURNE	079/106	6	$6,588	$925	$83
S16	PINKHAMS GRANT	080/094	6	$21,685	$1,470	$165
S11	FARMINGTON	080/125	0	$0	$0	$0
S101	AUBURN	080/154	17	$18,325	$1,732	$165
	NORTH HAMPTON	081/093	15	$37,803	$2,043	$248
S16	DOVER	084/165	-1	$0	$0	$0
U3	ASHLAND	085/063	0	$0	$0	$0
S16	GORHAM	087/050	6	$0	$0	$0
S28	ALLENSTOWN	088/067	4	$0	$0	$0
S101	AUBURN	088/162	17	$8,687	$2,574	$83
S16	GORHAM	092/058	6	$15,960	$1,019	$165
S16	JACKSON	092/130	6	$7,512	$1,073	$83
S16	WAKEFIELD	093/039	2	$0	$0	$0
US 202	ROCHESTER	093/110	0	$0	$0	$0
S101	CANDIA	095/069	19	$17,072	$1,322	$165
S16	ROCHESTER	095/097	-1	$0	$0	$0
US 202	ROCHESTER	095/106	0	$0	$0	$0
	SEABROOK	096/120	-48	-$56,028	-$3,015	-$335
S16	GREENS GRANT	096/136	6	$3,465	$792	$83
S11	ALTON	096/287	0	$0	$0	$0
S28	BARNSTEAD	097/089	4	$0	$0	$0
S16	TAMWORTH	097/165	6	$3,165	$550	$83
S16	GORHAM	098/071	6	$1,133	$647	$83
S16	MILTON	098/115	0	$0	$0	$0
S125	LEE	099/124	166	$7,201	$3,600	$250
U3	HOOKSETT	100/165	4	$0	$0	$0
S11	GILFORD	102/099	0	$0	$0	$0
S16	WAKEFIELD	104/042	2	$0	$0	$0
	PORTSMOUTH	104/126	-49	-$28,808	-$2,955	-$168
U2	GORHAM	105/089	6	$22,557	$1,455	$165
	PORTSMOUTH	105/125	-50	-$45,073	-$4,623	-$168
S16	DOVER	105/133	1	$0	$0	$0
U3	HOOKSETT	105/170	4	$0	$0	$0

PRIMARY ROUTE	TOWN NAME	BRIDGE NO.	Truck Vol. Change	Deck Repair	Deck Joints	Scuppers
S16	MARTINS LOC.	105/171	6	$0	$0	$0
S16	ROCHESTER	106/092	-1	$0	$0	$0
S16	DOVER	106/133	-1	$0	$0	$0
U3	ASHLAND	107/094	0	$0	$0	$0
S28	ALLENSTOWN	107/098	4	$0	$0	$0
U4	NEWINGTON	112/107	-1	$0	$0	$0
S28	WOLFEBORO	112/110	4	$0	$0	$0
S16	DOVER	113/111	1	$0	$0	$0
S16	DOVER	113/112	-1	$0	$0	$0
	HAMPTON	113/168	-14	-$41,257	-$2,245	-$248
S125	EPPING	114/051	166	$55,181	$4,050	$250
U3	GILFORD	114/066	0	$0	$0	$0
	MADBURY	114/084	17	$11,186	$1,025	$165
S11	GILFORD	115/147	0	$0	$0	$0
S16	ROCHESTER	117/088	-1	$0	$0	$0
U3	CAMPTON	118/126	0	$0	$0	$0
	MADBURY	120/096	17	$9,207	$921	$83
	DOVER	121/106	17	$30,508	$1,919	$165
	ROCHESTER	121/121	149	$0	$0	$0
S16	OSSIPEE	123/324	6	$2,272	$673	$83
S16	DOVER	127/104	15	$16,693	$1,054	$165
	ROCHESTER	127/106	0	$0	$0	$0
S28	BARNSTEAD	131/108	4	$0	$0	$0
	DOVER	131/123	33	$28,170	$2,415	$165
U4	LEE	131/127	17	$9,157	$990	$83
U3	LACONIA	131/154	0	$0	$0	$0
S16	DOVER	132/101	1	$0	$0	$0
S16	DOVER	132/102	15	$24,370	$1,420	$165
S101	CANDIA	133/074	19	$7,710	$881	$83
S101	CANDIA	133/075	17	$7,710	$881	$83
S101	RAYMOND	134/102	17	$8,150	$881	$83
S11	FARMINGTON	134/132	0	$0	$0	$0
U3	LACONIA	135/128	0	$0	$0	$0
S16	OSSIPEE	137/299	6	$14,133	$986	$165
U3	HOLDERNESS	140/088	0	$0	$0	$0
S16	MILTON	141/122	0	$0	$0	$0
U3	PLYMOUTH	141/143	0	$0	$0	$0
U3	PLYMOUTH	142/145	0	$0	$0	$0
S16	JACKSON	144/056	6	$12,454	$1,075	$165
	LEE	144/142	17	$1,787	$752	$83
S101	RAYMOND	146/103	19	$17,207	$1,530	$165
S28	WOLFEBORO	146/108	4	$0	$0	$0
S125	EPPING	146/111	166	$14,175	$2,700	$250
S16	ROCHESTER	147/099	-1	$0	$0	$0
U1	NORTH HAMPTON	148/132	97	$13,325	$2,538	$250
	ROCHESTER	149/113	149	$13,912	$2,100	$250
U3	PLYMOUTH	149/160	0	$0	$0	$0
S28	CHICHESTER	151/147	4	$0	$0	$0
S16	OSSIPEE	152/268	6	$5,294	$683	$83
U3	PLYMOUTH	154/087	0	$0	$0	$0

PRIMARY ROUTE	TOWN NAME	BRIDGE NO.	Truck Vol. Change	Deck Repair	Deck Joints	Scuppers
S125	BARRINGTON	154/118	149	$7,351	$4,201	$250
	ROCHESTER	155/110	149	$9,352	$2,580	$250
	EXETER	156/060	14	$16,978	$1,327	$165
	ROCHESTER	157/110	149	$54,276	$4,257	$500
S11	ALTON	157/193	0	$0	$0	$0
S125	ROCHESTER	158/110	149	$54,848	$4,302	$500
	ROCHESTER	158/113	1	$0	$0	$0
S16	DOVER	160/083	15	$12,625	$896	$165
U1	PORTSMOUTH	161/062	97	$5,655	$2,262	$250
S16	MILTON	162/110	0	$0	$0	$0
U1	HAMPTON	162/112	78	$15,619	$2,550	$250
U1	HAMPTON	163/184	78	$36,000	$3,600	$500
S11	ALTON	163/184	0	$0	$0	$0
S16	OSSIPEE	165/248	6	$11,558	$925	$83
U2	SHELBURNE	168/079	6	$5,503	$863	$83
S16	CONWAY	170/071	6	$34,637	$1,358	$248
S16	CONWAY	173/062	6	$4,492	$1,198	$83
S16	ROCHESTER	176/133	1	$0	$0	$0
S16	ALBANY	179/056	6	$1,960	$713	$83
S16	OSSIPEE	180/232	6	$2,754	$1,049	$83
	DOVER	181/039	-1	$0	$0	$0
	PORTSMOUTH	184/124	-122	-$59,816	-$5,652	-$500
S25	MEREDITH	184/138	0	$0	$0	$0
S28	WOLFEBORO	185/104	4	$0	$0	$0
S25	MEREDITH	186/145	0	$0	$0	$0
S28	ALTON	186/155	4	$0	$0	$0
S16	MILTON	187/109	0	$0	$0	$0
	PORTSMOUTH	191/131	-1	$0	$0	$0
U1	HAMPTON FALLS	194/059	78	$6,660	$3,552	$250
S28	OSSIPEE	194/146	4	$0	$0	$0
S16	ROCHESTER	194/149	-1	$0	$0	$0
S28	ALTON	196/278	4	$0	$0	$0
U4	PORTSMOUTH	198/123	-30	-$19,676	-$1,859	-$165
U4	DOVER	201/025	-11	-$127,119	-$2,869	-$660
S16	BARTLETT	202/172	6	$26,897	$1,559	$165
S11	NEW DURHAM	204/056	0	$0	$0	$0
S125	ROCHESTER	206/110	149	$40,162	$4,050	$500
	PORTSMOUTH	206/121	-137	-$32,602	-$3,726	-$250
	PORTSMOUTH	206/122	-123	-$32,602	-$3,726	-$250
U4	PORTSMOUTH	209/179	-1	$0	$0	$0
ST RT 109	WAKEFIELD	211/050	1	$0	$0	$0
S16	WAKEFIELD	230/057	0	$0	$0	$0
	PORTSMOUTH	231/125	-137	-$99,753	-$7,458	-$250
S16	OSSIPEE	232/121	2	$0	$0	$0
S16	MILTON	237/126	0	$0	$0	$0
S16	OSSIPEE	238/112	2	$0	$0	$0
U302	BARTLETT	241/137	6	$16,644	$1,387	$165
U1	PORTSMOUTH	247/084	94	$261,211	$6,090	$1,500
	PORTSMOUTH	258/128	-123	-$3,529,269	-$59,566	-$4,500
	Total Bridge Maintenance Costs: NH Study Network			-$2,921,642	$9,693	$4,368

Exhibit 48B: Maine Bridge Maintenance Cost Impacts

BRIDGE NAME	FEATURE ON	TOWN NAME	Volume Change	Deck Repair Cost	Deck Joint Repair	Scupper Repair
NEWOEGIN CULVERT	MTPK	Sabattus	-41	$0	$0	$0
LOCUST ST BRIDGE	LOCUST STREET	Lewiston	-7	-$8,437	-$34,125	-$165
CITY FARM CULVERT	MTPK	Lewiston	-33	$0	$0	$0
NO NAME BROOK CULVERT	MTPK	Lewiston	-41	$0	$0	$0
B&ARR/US RTE 1 RR#208-96	BANGOR & AROOSTOOK RR	Presque Isle	1	$0	$0	$0
MEADER BROOK	MTPK	Falmouth	-80	$0	$0	$0
FOREST LAKE BROOK	MTPK	Gray	-80	$0	$0	$0
PLEASANT RIVER	MTPK	Gray	-80	-$10,500	-$44,100	-$1,000
COLLIER BROOK	MTPK	Gray	-80	-$10,500	-$44,100	-$1,000
FOSTER BROOK	MTPK	New Gloucester	-80	$0	$0	$0
CONGRESS STREET	CONGRESS ST	Portland	124	$64,500	$259,290	$500
FORE RIVER	MTPK	Portland	-94	$0	$0	$0
POTTERS BROOK	MTPK	Litchfield	-30	$0	$0	$0
RTE1 197	RTE 197	Litchfield	5	$0	$0	$0
MAIN ST BR.	MAINE CENTRAL RR	Fairfield	0	$0	$0	$0
CAPE NEDDICK RIVER	MTPK	York	-137	$0	$0	$0
JOSIAS RIVER	MTPK	York	-137	$0	$0	$0
WEBHANNET RIVER	MTPK	Wells	-137	$0	$0	$0
BRANCH RIVER	MTPK	Wells	-122	$0	$0	$0
THATCHER BROOK	MTPK	Biddeford	-155	$0	$0	$0
BRANCH OF SACO	MTPK	Biddeford	-155	$0	$0	$0
CASCADE BROOK	MTPK	Saco	-155	$0	$0	$0
ELM ST BR	BOSTON & MAINE ROAD	Biddeford	57	$19,557	$78,792	$0
COLLEGE AVE CROSSING	MCRR	Waterville	0	$0	$0	$0
PENOBSCOT BRIDGE	ROUTE 15	Bangor	4	$0	$0	$0
BERWICK	ROUTE 9	Berwick	0	$0	$0	$0
BRIDGE STREET	BRUNSWICK AVE	Gardiner	-44	-$54,057	-$217,185	-$335
BRETTUNS POND	#4	Livermore	0	$0	$0	$0
CAIN	ROUTES 11 & 100	Clinton	4	$0	$0	$0
CLARK	RTE 143	Presque Isle	1	$0	$0	$0
DILL	RTE 196 & MTA ON RAMP	Lewiston	-7	$0	$0	$0
PARKMAN RD / FERGUSON	ROUTE 150 (MAIN STREET)	Cambridge	0	$0	$0	$0
FROST	#108	Rumford	1	$0	$0	$0
GUILFORD MEMORIAL	6-15-16-150	Guilford	0	$0	$0	$0
KENNEBUNK	US 1	Kennebunk	-16	-$8,286	-$33,680	-$165
MAIN STREET	US 1	Ellsworth	-4	$0	$0	$0
MAIN STREET	US2-100	Newport	4	$0	$0	$0
MAIN STREET	ROUTES 2.8&US201	Norridgewock	0	$0	$0	$0
MECHANIC FALLS	ROUTES 11 & 121	Mechanic Falls	0	$0	$0	$0
MIDDLE RANGE	26	Poland	-12	-$1,305	-$5,511	-$165
MILL POND	#4-27	Farmington	0	$0	$0	$0
MILO EAST	#16	Milo	0	$0	$0	$0
MORSE	ROUTE 108	Rumford	1	$0	$0	$0
NEAL	ROUTE 9	North Berwick	-20	-$5,685	-$23,255	-$165
NEW MILLS	RTE 9 & 126	Gardiner	-59	-$15,829	-$63,818	-$335
MARGARET CHASE SMITHN	US2 & US201	Skowhegan	0	$0	$0	$0
PARSONS MILL	MINOT AVE RTE 11-121	Auburn	0	$0	$0	$0
PEABODY SCHOOL	ROUTE 2	Gilead	-2	$0	$0	$0
PROSPECT AVE	ROUTE 2	Rumford	1	$0	$0	$0

BRIDGE NAME	FEATURE ON	TOWN NAME	Volume Change	Deck Repair Cost	Deck Joint Repair	Scupper Repair
RED	US 2	Bangor	1	$0	$0	$0
SAW MILL	ROUTE 26	Paris	-12	$0	$0	$0
SMITH BROOK	US #2	Lincoln	1	$0	$0	$0
SNOW	ROUTES 4&9	North Berwick	99	$16,964	$69,432	$500
MARGARET CHASE SMITH S	US2 & US201	Skowhegan	0	$0	$0	$0
WILD RIVER	ROUTE 2	Gilead	-2	$0	$0	$0
WOOLEN MILL	201	Skowhegan	0	$0	$0	$0
JAMES B. LONGLEY MEM.	MAIN ST US 202	Auburn	44	$236,075	$945,872	$838
STATE ST.	US 2	Bangor	5	$0	$0	$0
MAIN STREET	RTE 11-100-US202	Lewiston	44	$28,488	$115,205	$670
JORDAN MILL	US 2 A	Macwahoc Plt	1	$0	$0	$0
NEWELL BROOK BR.	RTE 9	Durham	1	$0	$0	$0
FAIRGROUNDS CROSSING	MAINE CENTRAL RR	Lewiston	47	$22,364	$90,149	$0
MCRR CROSSING	115	Yarmouth	1	$0	$0	$0
DURHAM	RTE 9-125	Durham	1	$0	$0	$0
MILL	US 2 A	Haynesville	1	$0	$0	$0
CNRR	CNRR	Mechanic Falls	0	$0	$0	$0
BARKER BROOK	197	Richmond	-4	$0	$0	$0
CRYSTAL LAKE OUTLET	#117	Harrison	10	$3,604	$14,969	$165
WYMAN CROSSING UNDER	MAINE CENTRAL RR	Fairfield	0	$0	$0	$0
JEPSON BROOK	202;RMPS A;D;MCRR;PET.ST	Lewiston	47	$0	$0	$0
PAUL DAVIS MEMORIAL	HIGH ST	Bath	1	$0	$0	$0
WEST APPROACH	SMO RAILROAD	Bath	1	$0	$0	$0
WARD	9-202	Newburgh	0	$0	$0	$0
HARDY BROOK	US 2-4	Farmington	1	$0	$0	$0
FRAZIER	TOWN WAY	Lisbon	6	$0	$0	$0
HORRS	ROUTE 35	Waterford	10	$4,665	$18,949	$165
AUGUSTA MEMORIAL	100;201;202	Augusta	18	$233,665	$935,105	$165
PLEASANT POND	197	Richmond	-10	$0	$0	$0
WATER STREET	STATE OF MAINE RR	Hallowell	-28	-$4,604	-$18,563	$0
SABATTUS RIVER	ROUTE 126	Sabattus	5	$0	$0	$0
COOMBS	RT 125	Bowdoin	6	$0	$0	$0
HAYNESVILLE	US 2A	Haynesville	1	$0	$0	$0
POWNAL CENTER	9	Pownal	1	$0	$0	$0
LEWIS	ROUTES 4A & US202	Alfred	149	$8,652	$35,844	$500
STOCKTON SPRINGS UNDRP	CHURCH ST	Stockton Sprgs	-3	$0	$0	$0
KENNEBUNK RIVER	111	Lyman	-22	$0	$0	$0
RT #1 UNDERPASS	MCRR	Brunswick	1	$0	$0	$0
GOLF COURSE TUNNEL		South Berwick	99	$0	$0	$0
				$519,331	**$2,079,269**	**$173**

The maintenance costs presented in **Exhibits 48A&B** were calculated based on a five year maintenance period. The maintenance costs were weighted for several ranges of truck volume change. A change of 5 or fewer trucks per day due to a change in policy was assumed to have little or no effect on maintenance of a structure. For volume changes greater than 75 trucks per day, the full cost factor of 1 (-1) was used. The cost factor was reduced for volume changes between 5 and 75 in one third increments, i.e.; 5 to 35 trucks per day yielded a cost factor of 0.33 (-0.33) and 35 to 75 trucks per day yielded a cost factor of 0.67 (-0.67).

Results for New Hampshire are dominated by a large bridge (470,569 square feet of deck surface) on the Turnpike. The estimated maintenance on this single structure due to the exemption is more than $705,000. When annualized, ending the current federal weight exemption on the New Hampshire Turnpike <u>decreases</u> overall state bridge maintenance expenditures by $581,516. In Maine, ending the current federal weight exemption on the Maine Turnpike <u>increases</u> the net statewide annual bridge maintenance expenditures by $519,755.

Major Rehabilitation Costs: The cost for major rehabilitation was based on the total square feet of the bridges analyzed. The type of treatments considered under the major rehabilitation costs would include deck replacement; including deck joint and drainage system replacement, approach slab replacement, repainting, structural repair of corrosion and deterioration, and safety improvements. A major rehabilitation project as described above would be necessary every 25 years on average. Increased wear and tear on the structures could reduce this interval by as much as 5 years. With a five year reduction in the rehabilitation interval, it would be necessary to perform major rehabilitation more than once in the structure's life. This would most likely be economically sound for longer structures that would have higher replacement costs. For purposes of this study, it is assumed that increasing truck weights would result in a second major rehabilitation project being performed on structures over 200 feet in total length.

Five structures in New Hampshire fell into this category:

Route #	Town	Bridge ID	Rehabilitation Cost
	NORTH HAMPTON	081/093	$504,040
S16	DOVER	132/102	$324,936
S16	CONWAY	170/071	$461,830
U1	PORTSMOUTH	247/084	$3,482,818
S16	BARTLETT	202/172	$358,630
25-Year Rehabilitation Cost Total		**$5,132,254**	

Three structures in Maine fell into this category:

Route #	Town	Bridge ID	Rehabilitation Cost
CONGRESS ST	Portland	0343	$860,000
MAIN ST / 202 Auburn	3076	$3,147,660	
100;201;202	Augusta	5196	$3,115,530
25-Year Rehabilitation Cost Total			**$7,123,190**

The estimated rehabilitation cost for bridges on non-turnpike diversion routes in the New Hampshire Turnpike is $5,132,254, and the estimate for the three structures non-turnpike routes in Maine is $7,123,190. Major rehabilitation costs are based on a 25 year time horizon. The annualized cost for major rehabilitation in New Hampshire is $205,290, and $284,928 for Maine.

The bridge analysis found that removing the federal weight exemption on New Hampshire Turnpike would result in overall annual bridge maintenance and rehabilitation <u>savings of $376,226 per year</u> in New Hampshire. Ending the current exemption on the Maine Turnpike would result in overall bridge maintenance and rehabilitation <u>cost increases to the state of Maine by $804,683 per year.</u>

Other Economic and Social Impacts

Toll Revenue Impacts

Currently 5 and 6 axle TST vehicles using the New Hampshire and Maine Turnpikes pay tolls as they pass through plazas located on the Turnpikes. If the current weight exemption were ended it is expected that these vehicles would divert to state highways allowing higher weights. The table below reflects the anticipated fiscal impacts based on the modeled changes in 5 and 6 TST traffic. The change in volume at each toll plaza has been multiplied by the minimum mainline cash rate for each vehicle type.*** The results in **Exhibit 49** suggest that potential revenue loss from the Maine Turnpike is nearly $650,000 annually. Revenue losses for the New Hampshire Turnpike are approximately $95,000.

Exhibit 49

Toll Plaza	State	5-Axle Toll Rate (Cash)	Annual Change in 5-axle TST Traffic	Annual Revenue Loss - 5 Axle TST	6-Axle Toll Rate (Cash)	Annual Change in 6-axle TST Traffic	Annual Revenue Loss - 6 Axle TST	Combined 5 & 6 axle TST Annual Toll Revenue Loss
York	ME	$2.20	-20,540	-$45,188	$2.20	-47,060	-$103,532	**-$148,720**
Wells	ME	$0.75	-20,540	-$15,405	$0.75	-47,060	-$35,295	**-$50,700**
Kennebunk	ME	$0.75	-20,540	-$15,405	$0.75	-54,340	-$40,755	**-$56,160**
Biddeford	ME	$0.75	-22,620	-$16,965	$0.75	-62,140	-$46,605	**-$63,570**
Saco	ME	$0.75	-24,440	-$18,330	$0.75	-65,780	-$49,335	**-$67,665**
Scarborough	ME	$0.75	-24,700	-$18,525	$0.75	-65,780	-$49,335	**-$67,860**
I-295	ME	$0.75	-24,700	-$18,525	$0.75	-65,780	-$49,335	**-$67,860**
So. Portland	ME	$0.75	-7,280	-$5,460	$0.75	-26,000	-$19,500	**-$24,960**
Congress/ Jetport	ME	$0.75	-7,280	-$5,460	$0.75	-26,000	-$19,500	**-$24,960**
Westbrook	ME	$0.75	-13,780	-$10,335	$0.75	-46,540	-$34,905	**-$45,240**
Falmouth	ME	$1.50	-5,720	-$8,580	$1.50	-14,820	-$22,230	**-$30,810**
Total for Maine Turnpike				**$-178,178**			**$-470,327**	**$-648,505**
Hampton	NH	$3.50	-12,740	-$44,590	$4.00	-12,740	-$50,960	**-$95,550**
Total Annual Loss in Toll Revenues				**-$222,768**			**-$521,287**	**-$744,055**

Impacts to Shippers and Carriers of Heavy Commodities

The consultant team also interviewed 15 companies in Maine, and 9 companies in New Hampshire that ship or haul heavy commodities, primarily timber, bulk liquids, stone and aggregates, garbage and heavy equipment. Phone interviews with these companies were conducted over two different periods during the course of the study. In addition to gaining information about preferred routes if the Turnpike systems were unable to carry heavy loads, the survey questionnaire also asked companies how losing the current weight exemption would affect their businesses.

*** Note: Tolls rates vary by direction, distance traveled, and whether the vehicle is on the mainline facility or exiting/entering via a ramp. Discounted rates are also offered for participating in electronic toll collection programs.

Nearly all respondents (88%) indicated that the current weight limit exemption was either "essential" or "very important" to their businesses. Respondents believed that the Turnpikes are the safest roadways; these highways are away from population concentrations, the roads are multi-lane, well maintained, and enable overall less time on the roadway for the transportation of heavy or dangerous commodities. Sample comments from the interview process are listed below:

- *"The exemption is important for the cost effectiveness of the fleet as well as for the raw materials coming into our facility. Being able to carry 20,000 lbs more per load is critical for the business."*
- *"Safety is our biggest concern. The interstate, including the Maine and New Hampshire Turnpikes are the safest roads for heavy vehicle operations and petroleum transport."*
- *"The exemption saves time, labor dollars and wear and tear on equipment. On the routes taken, using an interstate can reduce trip time by one half."*
- *"The time-delivery ratio is critical. Now with the driver hours effectively shortened, time waiting in line at terminals may present a problem coupled with longer transit times if the Turnpikes can't be used. The drivers may not get back before the shift ends."*
- *"The exemption decreases the risk of exposure to hazardous materials, such as gasoline, for high population areas and sensitive shore and waterways."*

Companies generally responded that the exemption on the Maine and New Hampshire Turnpikes save time and money, observing that Interstate Highways are "built better." If heavy loads were not allowed on the Maine and New Hampshire Turnpikes, respondents said those loads would be routed on the adjacent state routes. The general comment was that everyone wins; Interstates better able to handle heavy loads and easier to maintain. Respondents believed that weight enforcement is easier as well, noting that weigh-in-motion stations can be used more effectively on exempt Interstate routes because they would be the routing of choice for all heavy haulers.

The Effect of Discontinuing the Exemption: When asked what effect losing the Congressional exemption on the Maine / New Hampshire Turnpike System would have, nearly all companies responded that serious negative impacts on their businesses would result. The types of consequences that companies predicted would result from losing the exemption were listed below. (The frequency of the response is shown in parenthesis):

- Add new equipment (22%)
- Additional drivers/shifts (30%)
- Reroute existing equipment (45%)
- Outsource transportation (3%)

One company with ten heavy haul vehicles estimated that it would have to expand its fleet by one-third, which would also require one-third more drivers and total at least $300,000 to $400,000 in additional costs each year. Another said losing the exemption would increase the truck traffic by about one-third and promote a greater deterioration of the roadways due to increased numbers of trucks and potentially more damaging five-axle configurations.

In general the opinion of the respondents was that discontinuing the exemption would cost their companies substantially more money, would significantly increase transport time, and would dramatically increase safety risks. All respondents expressed a desire to see the weight limit exemption applied to all of the interstates in Maine. Several of the companies remarked that such a positive change would allow their businesses to grow.

Impacts to Communities

Thirteen city officials from seven towns in Maine were also contacted for their opinions about the federal weight policy on the Interstate Highway System in Maine. Three of these communities, Falmouth, Yarmouth and Freeport are located near or adjacent to the Maine Turnpike. The city managers and police chiefs from these three towns were among the officials contacted. Overall, impacts of large trucks in these communities are considered very significant. One town manager said that since the exemption on the Turnpike, the city now experienced fewer complaints about truck traffic and noise.

The police chiefs indicated that bringing large trucks through downtowns created unnecessary safety hazards, especially if these trucks were transporting hazardous materials. Alternate routes like U.S. 1 are heavily used by tourists and often bring traffic through historic city centers.

Without exception, every local official interviewed expressed strong personal and community support for allowing large, heavy trucks on the Interstate System in Maine.

A complete summary of the interviews conducted can be found in **Appendix E.**

Related Studies

There have been a number of recent studies, examining the implications of changing truck size and weight policy at a state or national level, including the TEA-21 mandated studies in Colorado and Louisiana. Two prominent examinations of U.S. truck size and weight policy were also conducted, one by the U.S. Department of Transportation (USDOT), and the other by the Transportation Research Board (TRB). Here is a brief summary of these study findings.

Regulation of Weights, Lengths, and Widths of Commercial Motor Vehicles – TRB Special Report 267, (2002):[†††] Also requested by Congress in TEA-21. This committee report is based primarily on the review of previous studies and the opinions of an expert panel:

- The study's first recommendation concludes: "***Opportunities exist for improving the efficiency of the highway system through reform of federal truck size and weight regulations****. Such reform may entail allowing larger trucks to operate. Present federal standards are for the most part the outcome of a series of historical accidents instead of a clear definition of objectives and analysis of alternatives. The regulations are poorly suited to the demands of international commerce….The greatest deficiency of the present environment may be that it discourages private- and public-sector innovation aimed at improving highway efficiency and reducing the costs of truck traffic…*"
- On the topic of size and weight as it relates to safety: "*The committee found that previous studies tend to correlate increases with truck size and weight to reductions in vehicle miles of travel (VMT), lowering the inherent risk due to exposure and hence reduce the overall potential for truck crashes.*
- On pavement wear related to TS&W, the panel concluded: "*If axle weights are not altered, pavement cost per ton-mile of freight will be little affected by a change in the GVW limits.*
- On bridges: "*Bridge cost estimates derived by the method of past studies assume replacement of bridges regardless of whether the cost of replacement is justified by the gain in safety and do not fully take into account the capabilities of highway agencies to maintain bridge safety by more cost-effective means than replacing all suspect bridges...*"

The Comprehensive Truck Size and Weight Study (CTSWS), FHWA (2000)[‡‡‡] was undertaken to develop a policy architecture that would allow state and regional practitioners to analyze changes in truck size and weight at a sub-national level. Among the key findings of that study:

- "There are…several key trends that are evident relative to truck safety in general and size and weight policy choices in particular. First, numerous analyses of crash data bases have noted that truck travel, as well as all vehicle travel, on lower standard roads (that is, undivided, higher speed limit roads with many intersections and entrances) significantly increases crash risks compared to travel on Interstate and other high quality roadways. **The majority of fatal crashes involving trucks occur on highways with lower standards…. The [fatal crash] involvement rate on rural Interstate highways is 300 percent to 400 percent lower than it is on other rural roadway types and is generally the same for all vehicle types.**"

[†††] Transportation Research Board, National Research Council; *Regulation of Weights, Lengths, and Widths of Commercial Motor Vehicles;* Special Report 267, National Academy Press, Washington D.C. 2002. pp. 2-39 to 2-45.
[‡‡‡] available online at www.fhwa.dot.gov/policy/otps/truck/

- The pavement LEFs presented in the report indicated that while a single six-axle TST vehicle operating at 97,000 lbs. is slightly more damaging to flexible pavements, when the reduction in trips to move a given quantity of freight is factored in, the heavier vehicle actually produces less damage for both rigid and flexible pavements. The report concluded that the use of a 97,000 lb. six-axle TST in favor of five-axle, 80,000 lb. TST would result in nationwide VMT reduction of approximately 10% and pavement cost savings. The study indicated that heavier trucks would increase highway agency and user costs associated with bridge replacement and maintenance.

EFFECT OF TRUCK WEIGHT ON BRIDGE NETWORK COSTS: The National Cooperative Highway Research Program (Project 12-51) – TRB (Draft Final Report, December 2002):

- *The current AASHTO fatigue truck model developed over a decade ago is found still valid for current truck traffic, based on the current WIM data used.*
- *The current AASHTO fatigue truck model may still be valid for a scenario of legalizing higher truck weights if thereby introduced new dominant truck configurations are not significantly different from the currently dominant 3S2 configurations.*
- *Truck wheel loads are important to RC deck fatigue. More research efforts are needed to understand and model their magnitude and effects in the field. One of the factors needing investigation is the interactive effect of steel reinforcement corrosion and wheel load induced concrete fatigue.*

State weight exemption studies mandated by TEA-21:

Preliminary Assessment of Pavement Damage Due to Heavier Loads on Louisiana Highways, LTRC, May 1999. Ref. No. FHWA/LA-98/321.:

- *"**Comparisons of NPW between the weight scenarios showed that increases in GVW have more effect on Louisiana state and US highways than on Interstate highways.** Any elevation in GVW over current limits increases the cost of overlays and decreases the length of time before an overlay is required. The cost increase due to raising the GVW is substantial. Fee structures need to be modified by the state legislature to pay for these costs through the current registration and overweight permit fee structure or some new tax such as a ton-mile tax."*[7]

Non-divisible Load Study, Colorado DOT, June 2001:

- *"The law change has been beneficial to the Colorado taxpayers. There is an increase in property, sales and income taxes from this industry. However, the highway trust fund suffers a negative impact due to less fuel taxes. Jobs are created in Colorado, and other businesses benefit form lower costs due to increase competition in building choices."*

- *"Negative impacts are minor. There is an increase in load on bridge structures. However due to axle load limitations still in place on the permits, and the fact that the loads are generally carried on major routes, there are no significant problems. There are negative impacts to the pavements of Colorado highways due to the increased weights of the loads. There is anywhere from a 5% to 20% increase in pavement damage due to increased loads. However, since the bulk of the routes traveled are designed to carry heavy loads, the VMT are small, for this industry only, the impacts are not significant."*[8]

Study Conclusions

The analysis assumes that removal of the current federal truck weight exemption on the Maine and New Hampshire Turnpikes would divert five and six axle TST combinations over 80,000 lbs. from the Turnpikes to non-Turnpike state highways. **Exhibit 50** summarizes the economic impacts that would result from removing the current federal weight exemption from the Maine and New Hampshire Turnpikes.

Exhibit 50: Annual Economic Impacts Associated with Removing the Current Federal Truck Weight Exemption on the Maine and New Hampshire Turnpikes

	Maine	New Hampshire	Total
Safety	$443,000	$98,000	$541,000
Pavement (Low)	$1,286,292	$41,847	$1,328,139
Pavement (High)	$2,376,772	$49,194	$2,425,966
Bridge	$804,483	-$376,226	$428,257
Tolls	$648,505	$95,550	$744,055
Total (Low)	**$3,182,280**	**-$140,829**	**$3,041,451**
Total (High)	**$4,272,760**	**-$133,482**	**$4,139,278**

Rescinding the federal truck weight exemption on the Maine and New Hampshire Turnpikes would cost the States of Maine and New Hampshire an additional $3 million to $4.1 million each year.

End Notes:

[1] *1997* Commodity Flow Survey, U.S. DOT, BTS and U.S. Department of Commerce. 1999.
[2] New Hampshire Revised Statutes Annotated (RSA), Title XXI Motor Vehicles; Chapter 266:18-d
[3] "*A Heavy Haul Network for the State of Maine – HHTN Identification and Needs Assessment*" – Final Report. Wilbur Smith Associates, November 26, 2001
[4] Federal Motor Carrier Safety Administration (FMCSA); Analysis Division: *Large Truck Crash Facts 2001*, January 2003.
[5] *Comprehensive Truck Size and Weight Study: Vol. III Scenario Analysis*, USDOT, August 2000. pp. VIII-3.
[6] Transportation Research Board (TRB), Transportation Research Record 1816: "*Cumulative Traffic Prediction Method for Long-Term Pavement Performance Models*" Christopher R. Byrum and Starr D,. Kohn, pp. 111
[7] Roberts, Freddy L., and Djakfar, Ludfi:. " Preliminary Assessment of Pavement Damage Due to Heavier Loads on Louisiana Highways" Louisiana Transportation Research Center, May 1999. pp. iii.
[8] TMS Consultants, LLC; LONCO INC.; Hook Engineering; Dr. George Hearn: Non-Divisible Load Study, Colorado DOT, May 2001. Executive Summary, online at: http://www.tmsconsultants.com/NondivLoadStudy.htm